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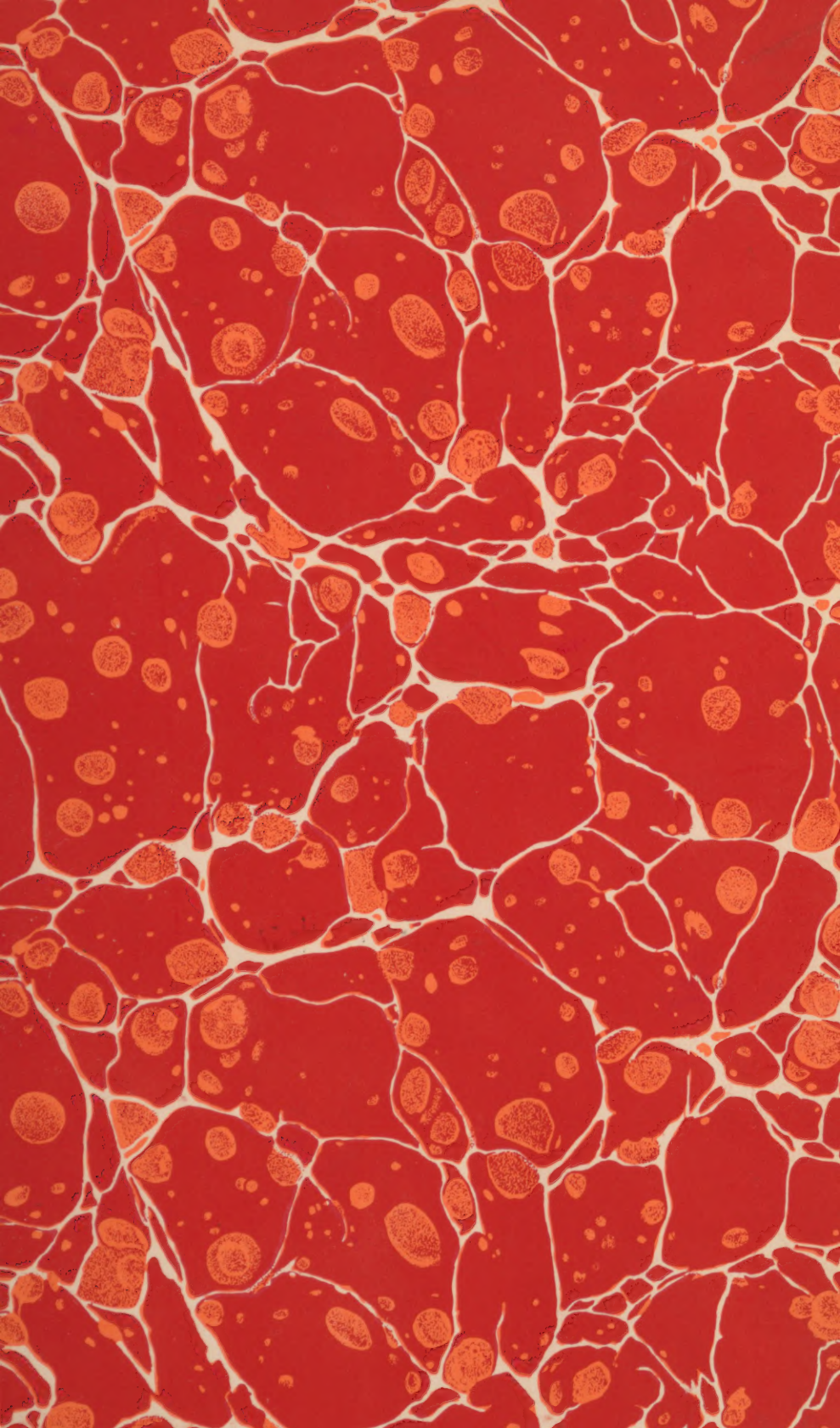
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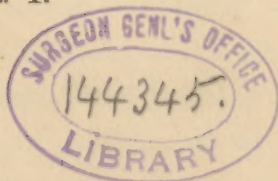


SYSTEM OF DISEASES
OF THE
EAR, NOSE, AND THROAT.

EDITED BY
CHARLES H. BURNETT, A.M., M.D.,

EMERITUS PROFESSOR OF OTOTOLOGY IN THE PHILADELPHIA POLYCLINIC; CLINICAL PROFESSOR
OF OTOTOLOGY IN THE WOMAN'S MEDICAL COLLEGE OF PENNSYLVANIA; AURAL
SURGEON TO THE PRESBYTERIAN HOSPITAL, ETC., PHILADEL-
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PREFACE.

THE close anatomical and pathological relations existing between the ear, the nose, and the throat often render it necessary that diseases of these organs be treated by the same hand, whether it be that of the general practitioner or that of the specialist. And even in the practice of the aurist, the rhinologist, or the laryngologist, cases must present themselves where a knowledge of the morbid processes in all of these organs is absolutely necessary for the proper treatment of special maladies in any one of them. These weighty facts have rendered it very desirable that a systematic work should be prepared which should present at one view a consideration of the diagnosis and treatment of diseases of the ear, of the nose, and of the throat, thus freeing the practitioner from the necessity of referring to separate treatises upon any one of these special departments of medical and surgical science.

Therefore the editor of this system has endeavored to place before the profession a practical work on the diagnosis and treatment of diseases of the ear, the nose, the naso-pharynx, the pharynx, and the larynx, composed of papers by eminent authorities upon the various subdivisions named. In these papers the authors have aimed to give practical conclusions arrived at by other investigators and by themselves, rather than to discuss theories.

The entire system is comprised in two volumes, the first volume being devoted to the ear, the nose, and the naso-pharynx, while the second volume is occupied with the consideration of the diseases of the pharynx and of the larynx.

The editor feels that he cannot adequately express his appreciation of the hearty co-operation in this undertaking which the authors of the papers in the system have so generously accorded him. He can only

assure them of his deepest gratitude for the very able papers they have contributed to this work, and of the consciousness on his part that they have enabled him to lay before the profession a systematic treatise of the greatest merit.

It is sincerely hoped that the readers of this system will find in it valuable rules of guidance in the conduct of their important special practice; and if these directions shall in any way prove of service in the relief of suffering, the editor will feel that he and his coadjutors are more than repaid for their labors in preparing them.

The editor embraces this opportunity of formally expressing his thanks to Mr. Joseph McCreery for his critical proof-reading.

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SYSTEM OF DISEASES OF THE EAR, NOSE, AND THROAT.

PART I. *Diseases of the Ear.*

ANATOMY AND PHYSIOLOGY OF THE EAR, AND TESTS OF HEARING.

BY WILLIAM SOTIER BRYANT, A.M., M.D.,
Assistant in Anatomy at the Harvard Medical School; Clinical Assistant to the Massachusetts Charitable Eye and Ear Infirmary; Aural Surgeon to the Boston Dispensary, etc., Boston, Massachusetts.

PART I. ANATOMY.

THE MACERATED HUMAN TEMPORAL BONE.

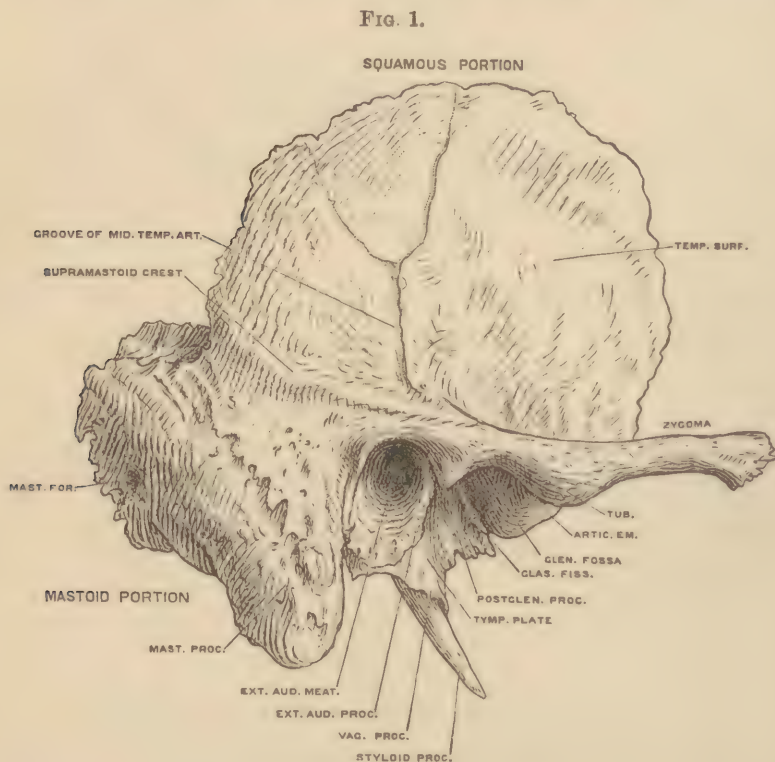
THE human temporal bone (Figs. 1, 2, and 6) contains the organ of hearing, and is situated at the base and side of the skull. It has three principal parts,—viz., the *squamous part*, which expands upward and forward, and from which the zygomatic process arises; the *mastoid part*, which is situated posteriorly, and between the other parts; and the *petrous portion*, a three-sided pyramid projecting inward and forward into the base of the skull. The base of this pyramid forms the external auditory osseous meatus.

The temporal bone articulates posteriorly and internally with the occipital bone, superiorly with the parietal, anteriorly with the sphenoid, through the zygoma with the malar bone, and by the articulation at the glenoid cavity with the inferior maxilla. (Fig. 1.)

The *squamous portion* expands forward and upward from the base of the petrous portion, its upper border forming an arc of about two-thirds of a circle.

The *inner surface* (Fig. 2) shows meningeal grooves and cerebral impressions. At its upper border the outer table is prolonged considerably beyond the inner, forming a thin scale with a roughened surface looking inward and overlapping the corresponding surface of the parietal bone. In front this border is thicker and articulates with the great wing of the sphenoid.

The *outer surface* (Fig. 1) is vertical for the most part, with a slight



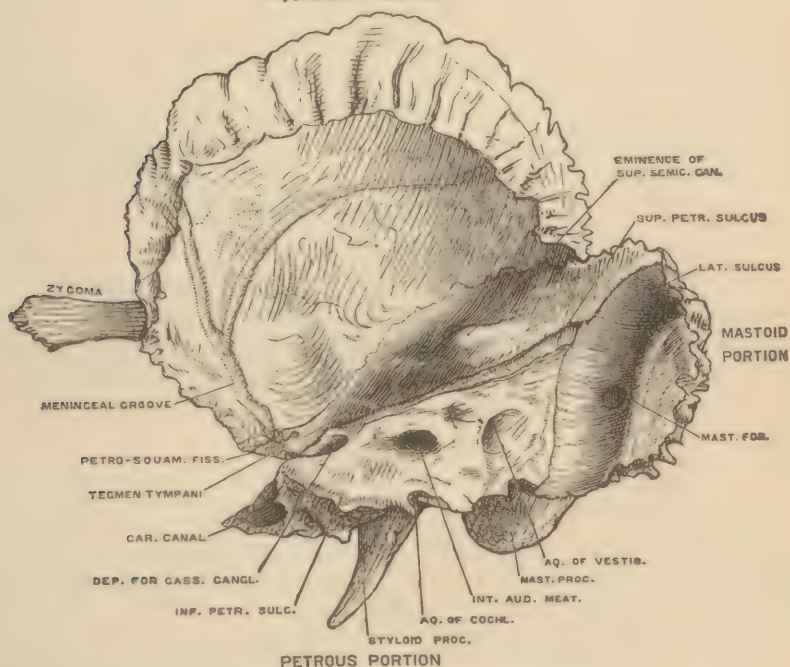
Right temporal bone, outer side (Quain).

convexity, and forms the greater part of the temporal fossa. Above the external auditory meatus there is a barely perceptible vertical furrow for the middle temporal artery. Posteriorly near where this surface turns in to become the upper wall of the meatus there is usually to be found a small pointed projection, called the *spina meatus*.

The *zygomatic process* arises from the lower part of this surface by a broad base projecting outward. It then turns forward, becomes narrow, and is twisted on itself, so that what was its upper surface becomes its inner, and it now has outer and inner surfaces and upper and lower borders. The upper

border is thinner and reaches farther forward than the under border. The extremity of the process is serrate, for articulation with the malar bone. The base of the zygoma has two roots: the anterior, which is called the *articular eminence* of the lower jaw, is continuous with the lower border of the zygoma; it is a broad convex ridge directed inward on the under surface of the temporal bone. There is a tubercle where it joins the zygoma, which gives attachment to the external lateral ligament of the jaw. The posterior root is prolonged backward from the upper border of the zygoma, passing above the auditory meatus, and is continued into the *linea temporalis*. Its posterior extremity marks the division between the mastoid and squamous

FIG. 2.
SQUAMOUS PORTION



Right temporal bone, inner side (Quain).

portions. Near the zygoma the lower border of this root descends in front of the auditory meatus, forming a conical process called the *post-glenoid*. The *glenoid fossa* lies between the two roots (Fig. 6): it is a large depression, and is divided by the fissure of Glaser into an anterior and a posterior part. The posterior part of this fossa is formed by the tympanic plate of the petrous portion of the bone. It lodges a part of the parotid gland, and is not connected with the articulation of the jaw. The anterior part of the fossa, together with the articular eminence, is covered by articular cartilage, and forms the concavo-convex articular surface for the lower jaw, the interarticular cartilage being interposed.

In front of the inner end of the articular eminence there is a small

triangular surface which forms part of the zygomatic fossa and is separated from the temporal fossa by an angle.

The *mastoid portion* (Fig. 1) of the temporal bone is prolonged downward behind the external meatus, forming a nipple-shaped projection called the *mastoid process*. This process is conical, somewhat flattened on the sides, and points downward and slightly forward. Its outer surface is more convex than the inner. Occasionally the process is divided by a deep groove passing across it from before backward. The mastoid process (Fig. 6) has a deep groove on its inner side, called the *digastric fossa*, which gives origin to the posterior belly of the digastric muscle; and on the inner side of this fossa there is a smaller groove for the occipital artery, which is called the *occipital groove*. The part of the mastoid portion lying on the inner side of the tip of the process is sometimes, in pneumatic bones, covered only by a very thin sheet of bone which forms the floor of the mastoid cells. Near the posterior border of the mastoid portion there is the *mastoid foramen* (Figs. 1 and 2), which is very variable in size and serves for the passage of a vein from the sigmoid sinus to the outside of the skull. The outer surface of the mastoid process (Fig. 1) is roughened, especially posteriorly, for the attachment of muscles, and exhibits many small vascular openings. From the re-entering angle formed by the squamous and mastoid portions, down nearly to the tip of the process, an irregular line or fissure may be traced on the outer surface of the mastoid bone. This is called the *mastoido-squamous suture*, and indicates the line of union of these two parts of the infantile temporal bone. Between the anterior surface of the base of the mastoid process and the posterior edge of the tympanic plate there is the more or less well marked *auricular fissure*.

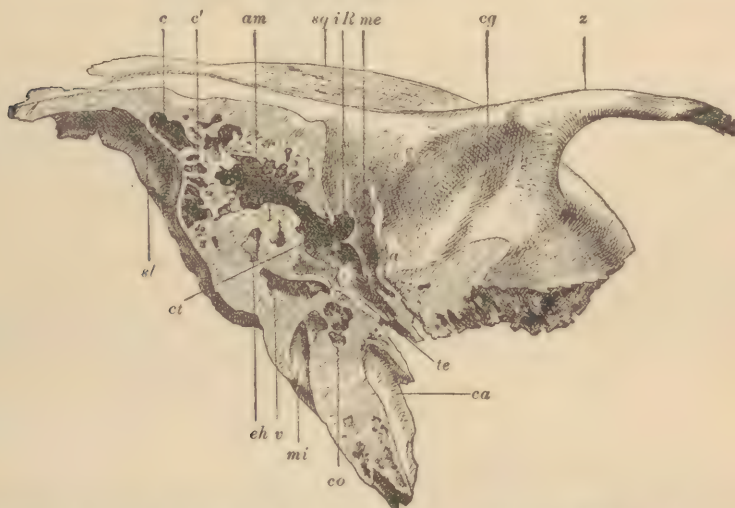
The internal cellular structure of the process can often be seen through the cortex, since its outer wall is frequently very thin, and may in exceptional cases be perforated at different points, so that the air-cells open directly upon the surface of the bone. Through these openings the mastoid cells and the tympanic cavity can be reached.

Dr. Giovanni Loja, after examining one hundred and sixty-eight skulls, states that if a line be taken from the centre of the digastric fossa to the apex of the process to represent the height, a horizontal line from the same point to the outer surface of the process as the thickness, and a horizontal line crossing the last from the anterior to the posterior margin of the process as the breadth, the height is twelve millimetres, the thickness thirteen millimetres, and the breadth nineteen millimetres; and, further, that in female skulls the measurements are about one millimetre less than in those of males. The average thickness of bone covering the mastoid cells is from one to two millimetres. The cells are sometimes so large that occasionally only a single cell is found. Out of sixty-eight cases, this was seen once on both sides and once unilaterally. The cells in the centre are usually the largest, and communicate with one another. In several cases the cells were limited to the base of the process, but sometimes they were found extending to the

side of the cranium, or even to the centre of the petrous bone, and into the occipital bone. Zuckerkandl found in one hundred pairs of temporal bones that the mastoid process was pneumatic in thirty-six and eight-tenths per cent., entirely diploetic and occasionally sclerosed in twenty per cent., and partly diploetic in forty-two and eight-tenths per cent., the cells being chiefly in the anterior and upper part of the process.

The tympanic cavity is considerably increased in capacity by the cellular space of the mastoid process. This cellular space is divided into two portions,—the horizontal portion, or *antrum mastoideum* (Fig. 3, *am*), a large empty space situated below the roof of the process (*tegmen mastoideum*), opening anteriorly immediately into the tympanic cavity through the upper

FIG. 3.



HORIZONTAL SECTION THROUGH THE MEATUS OF AN ADULT TEMPORAL BONE, LEFT UPPER HALF (after Politzer).—*sq*, squamous portion; *z*, zygomatic process; *cg*, glenoid fossa; *me*, external auditory meatus; *ct*, tympanic cavity; *il*, incisura Rivini; *te*, Eustachian tube; *am*, mastoid antrum; *c*, *c'*, mastoid cells; *mi*, internal auditory meatus; *v*, vestibule; *eh*, horizontal semicircular canal; *co*, cochlea; *ca*, carotid canal; *sl*, sigmoid sinus.

part of its posterior wall; and the vertical portion, or proper cellular part, which opens into the antrum.

The *mastoid antrum* (Fig. 4) is a large, usually oblong space: its size and direction are very variable, being dependent on the arrangement of the mastoid cells. The long axis is most often directed outward and backward. It is bounded above by the *tegmen mastoideum*, below by the mastoid cells (Fig. 4, *wz*), anteriorly by the posterior wall of the meatus and the tympanic cavity, posteriorly by the inner table of the skull in the region of the sigmoid sinus, externally by the upper mastoid cells, and internally by the petrous portion. The cellular spaces bordering the antrum mastoideum are formed by osseous lamellæ, which cross one another in different directions: their number and size are exceedingly variable, and they are, as a rule, in connection with one another and with the antrum. Usually the cells

immediately surrounding the mastoid antrum are long and narrow and radiate from it, and their walls form spiculæ projecting into the antrum ;

FIG. 4.



VERTICAL SECTION OF LEFT PETRO-MASTOID PORTION, INNER HALF (after Gruber).¹—*act*, canalis pro tensore tympani; *h*, hiatus Fallopii; *p*, promontory; *fo*, foramen ovale; *cF*, aqueduct of Fallopius, at this spot artificially opened, but not cut by the section; *tl*, tegmen tympani; *ep*, eminentia pyramidalis; *wz*, mastoid cells; *fsm*, stylo-mastoid foramen; *ch*, canalis pro chorda tympani; *fr*, fenestra rotunda; *ft*, fundus tympani; *tE*, Eustachian tube; *ec*, ear canal; *st*, septum canalis musculo-tubarii. A bristle passes through this canal, and another through the aqueduct of Fallopius, *as*.

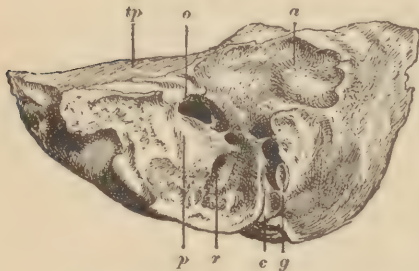
while the cells in the lower part of the process are more equilateral, with rounded angles.

The *mastoid cells* are situated (Fig. 9) behind the tympanic cavity, but

chiefly behind the external meatus, which together with the tympanic cavity forms their anterior boundary. These cells often communicate with the bony cells situated about the semi-circular canals, and with the diploe of the rest of the mastoid portion. It is very rare for the cells to communicate with the similar cells of a pneumatic occipital bone. The tegmen mastoideum is continued backward from the tegmen tympani. Politzer states that the distance between the mastoid antrum and the transition from the posterior wall of the osseous meatus to the planum mas-

toideum, measured on horizontal section, varies from six to fifteen millimetres.

FIG. 5.

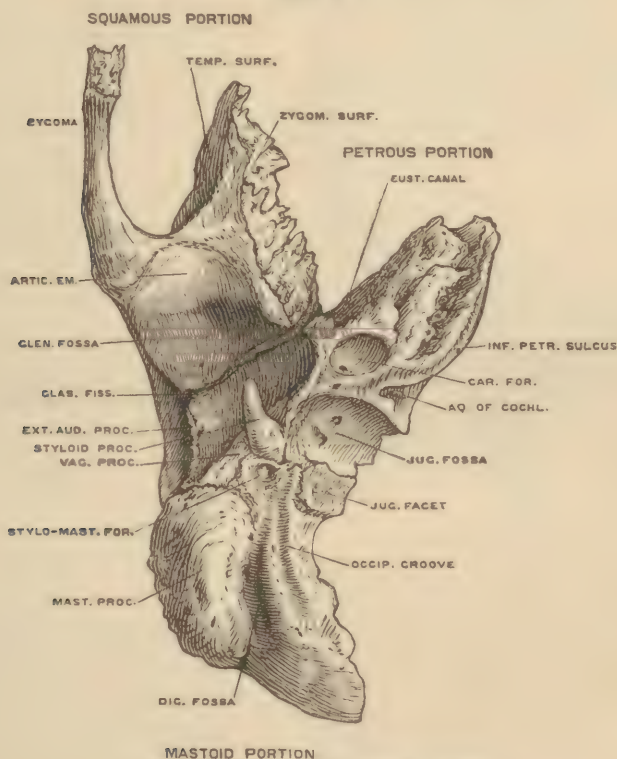


THE PETRO-MASTOID PORTION OF THE TEMPORAL BONE OF A NEW-BORN INFANT, SHOWING THE GLENOID FACET, *g*, ON THE POSTERIOR WALL OF THE CANALIS STYLOIDEUS, *c*: enlarged to double its size (Politzer).—*o*, fenestra ovalis; *r*, fenestra rotunda; *p*, promontory; *tp*, semicanalis pro tensore tympani; *a*, antrum mastoideum.

¹ The illustrations from Gruber used in this article are taken from the English translation of Gruber's "Diseases of the Ear," by the very kind permission of the translators, Dr. Edward Law and Mr. Coleman Jewell, of London, and with the consent of the publisher, H. K. Lewis, London.

The *inner* or *cranial surface* of the mastoid portion is marked by a deep groove, the *sigmoid fossa* or lateral end of the *lateral sulcus* (Fig. 2), which varies considerably in size and position and contains the *sigmoid sinus*. The following measurements of the shortest distance between the sulcus sigmoideus and the posterior wall of the osseous meatus were taken on fifty-five macerated adult bones. The place on the wall of the meatus which approached nearest the sulcus had no fixed position, varying between zero and four millimetres from the external orifice of the meatus, and averaging one and nine-tenths millimetres. The lines of the measurements were usually

FIG. 6.



Right temporal bone, from below (Quain).

horizontal, and at right angles to the wall of the meatus; when they varied from the horizontal, it was downward and backward. The greatest thickness was fifteen and a half millimetres; the least was five millimetres; the average was ten and one-third millimetres. In twenty-nine measurements the thickness was between nine and thirteen millimetres. In two cases the posterior surface of the petrous pyramid lay a little nearer the meatus than the sigmoid groove. The lateral fossa or sulcus forms the inner wall of the greater part of the mastoid cells, and the posterior wall of the rest. The fossa starts at the inner occipital protuberance, and passes forward over the inner surface of the posterior inferior angle of the parietal bone, out to the inner surface of the

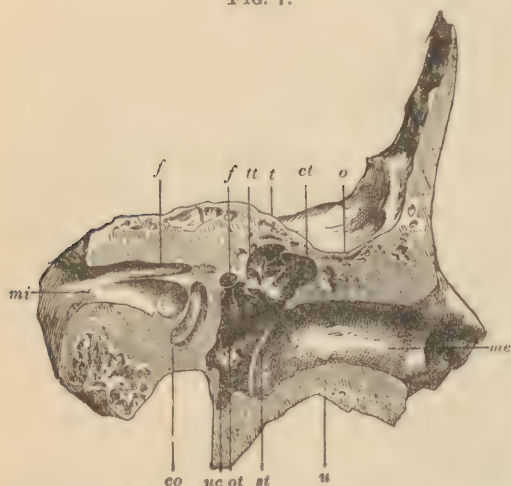
mastoid portion of the temporal bone, over the orifice of the mastoid foramen, and turns abruptly downward and inward under the petrous portion, forming the *jugular fossa*. The osseous lamella which separates the mastoid cells from the lateral sulcus is usually strong; in some cases, however, it is very thin, and even perforate, allowing the lining membrane of the cells and the venous wall to be in contact. In diploetic or sclerosed mastoids the sigmoid groove approaches much more nearly the posterior wall of the meatus and the external surface of the mastoid process than it does in pneumatic mastoids.

The *petrous portion* (Fig. 6), so called from its great hardness, contains the organ of hearing. It forms a three-sided pyramid with its base directed

FIG. 7.

outward, one surface looking downward, the superior or anterior, and the posterior surfaces being turned towards the interior of the skull.

The base of the pyramid contains the *external osseous auditory meatus*. It is a large canal with curved sides, somewhat flattened on its antero-inferior and postero-superior diameters, and consequently these diameters are the shortest, and the diameters at right angles to their plane, or the antero-superior and postero-inferior, are the longest. The plane of the long diameters of the meatus passes through the long axis of the manubrium of the malleus. (Figs. 7, 8, and 9.)



ANTERIOR HALF OF VERTICAL SECTION THROUGH THE EXTERNAL MEATUS OF RIGHT TEMPORAL BONE (after Politzer). —*mc*, external auditory meatus; *o*, upper wall of the meatus; *u*, lower wall of the meatus; *st*, sulcus tympanicus; *t*, tegmen tympani; *uc*, lower tympanic wall; *ot*, ostium tympanicum tubæ; *tt*, canalis pro tensore tympani; *ct*, niche in external wall of tympanum; *mi*, meatus auditorius externus; *f, f*, aqueduct of Fallopius; *co*, cochlea.

My own measurements of the osseous meatus give at the external orifice fifteen by ten millimetres, at the isthmus of the meatus nine by five and a half millimetres, and at the inner extremity nine and three-fourths by nine and one-third millimetres. The narrowest part is by the incisura Rivini; the shallowest, a little to the outside of the middle. The isthmus is the smallest part of the canal, and is midway between these two points. The length of the superior wall of the meatus from the incisura Rivini to where the squama turns into the horizontal part is from fourteen to sixteen millimetres. The anterior wall from the anterior edge of the tympanic plate to the anterior segment of the sulcus tympanicus measures fifteen to sixteen millimetres; the inferior wall from the outer edge of the tympanic plate to the sulcus, fifteen or sixteen millimetres; the posterior wall, fourteen or fifteen milli-

metres. Owing to the oblique direction of the annulus tympanicus, which forms the inner boundary of the osseous meatus, the lower anterior wall extends farther inward than the opposite wall. The distance between the sulcus tympanicus and the point on the inferior meatus where a perpendicular from the incisura Rivini would fall is from four to five millimetres. The distance between the sulcus tympanicus and the point on the anterior wall of the meatus where a horizontal line from the inner extremity of the posterior wall would intersect the anterior wall is five to seven millimetres.

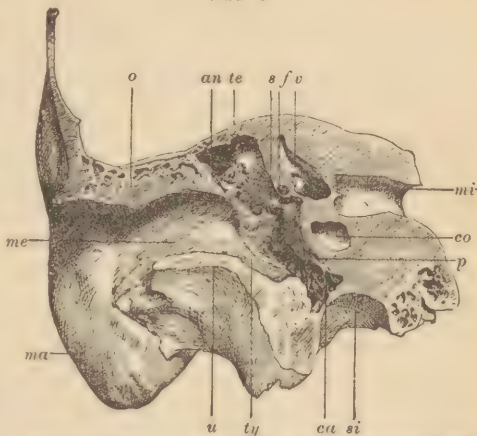
The long axis of the canal has a general inward, upward, and forward direction, complicated by a double curve. Looked at from above, it is convex anteriorly or concave posteriorly; looked at from in front or behind, the long axis is convex above and concave below.

FIG. 9.



HORIZONTAL SECTION OF RIGHT ADULT TEMPORAL BONE, LOWER HALF (after Politzer).—*a*, anterior wall of the meatus; *p*, lower wall of the meatus; *sl*, sulcus tympanicus; *f*, aqueduct of Fallopius; *ct*, canalis pro tensore tympani; *v*, vestibule, and at its floor the fissure leading to the scala tympani of the cochlea between the lamina spiralis and the lamina spiralis accessoria; *ch*, horizontal semi-circular canal; *co*, cochlea; *ca*, carotid canal; *w*, mastoid process; *st*, sigmoid sulcus.

FIG. 8.



POSTERIOR HALF OF VERTICAL SECTION THROUGH THE EXTERNAL MEATUS OF RIGHT TEMPORAL BONE (after Politzer).—*me*, external auditory meatus; *o*, upper wall of the meatus; *u*, lower wall of the meatus; *te*, tegmen tympani; *ca*, inferior wall of tympanic cavity; *ty*, sulcus tympanicus; *p*, promontory; *an*, mastoid antrum; *s*, eminentia stapedii; *f*, aqueduct of Fallopius; *v*, vestibule; *co*, cochlea; *mi*, meatus auditorius internus; *ma*, mastoid process; *si*, jugular fossa.

Also the anterior (antero-inferior) surface is very slightly convex; the posterior (postero-superior) is markedly concave. The superior (supero-anterior) border is convex, and the inferior (infero-posterior) border is very strongly concave.

The inner end of the canal opens into the tympanic cavity, and its average length is from fourteen to sixteen millimetres. The external orifice of the external osseous auditory canal is bounded above by the posterior root of the

zygoma. From this root inward the roof of the meatus is formed by the horizontal part of the squamous portion, called the *auditory plate*. The

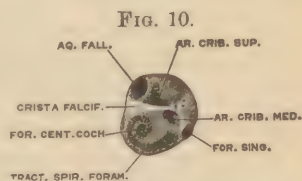
remainder of the circumference of the external orifice of the canal is formed chiefly by the *external auditory process* (Fig. 1), which has a curved uneven border for the attachment of the cartilaginous meatus. This process is the thickened outer extremity of the *tympanic plate*. The anterior part of the concave surface of this plate forms the anterior wall of the osseous meatus; while the antero-inferior surface forms the posterior segment of the glenoid fossa. The tympanic plate is often perforated by a foramen near its inner extremity, which is due to arrested development: this is the *foramen of Huschke*, and it connects the glenoid fossa with the external auditory meatus. The upper margin of the tympanic plate lies beneath the squamous portion, and forms the posterior border of the *fissure of Glaser*; while its lower margin descends ending in a sharp edge, which forms the *vaginal process*, partly surrounding the base of the styloid process. (Fig. 6.) The anterior border of the fissure of Glaser is formed by the squamous portion of the temporal bone. The fissure is a double cleft at its inner half, for the tympanic plate is here separated from the squamous portion by a descending process of the tegmen tympani,—this process forming the greater part of the outer wall of the canalis musculo-tubarius. Between this process and the tympanic plate there is a small slit, corresponding to the sulcus malleolaris of the annulus tympanicus (Fig. 34), which lodges the processus gracilis of the malleus, the long part of the anterior ligament of the malleus, and the tympanic branch of the internal maxillary artery, and also carries the chorda tympani nerve for a short distance till it reaches the *canal of Huguier*. This canal transmits the nerve parallel to the fissure of Glaser to the re-entering angle between the squamous and petrous portions, and opens just on the outer side of the canalis musculo-tubarius. Sometimes the canal of Huguier is not closed below, and forms part of the slit of the fissure. The outer portion of the Glaserian fissure is entirely closed.

The *inferior surface* of the petrous portion (Fig. 6) is nearly horizontal, and very irregular, and forms part of the inferior surface of the skull. From the surface rises the *styloid process*, which is long and tapering and is directed downward and slightly forward. Its base stands in front of the digastric fossa, and between them is the *stylo-mastoid foramen*, the external outlet of the aqueduct of Fallopius, which lodges the facial nerve. The *jugular facet* lies on the inner side of the stylo-mastoid foramen; it is a small irregular surface which is attached to the jugular facet of the occipital bone by synchondrosis. In front of this lies the *jugular fossa*, a smooth deep depression, which together with the jugular notch of the occipital bone forms the jugular foramen. The *carotid foramen*, lying in front of the jugular fossa, is the inferior extremity of the *carotid canal*. This canal, according to Politzer, is twenty-five to thirty millimetres long; its greatest diameter at its lower orifice is eight to nine millimetres; the diameter at its upper orifice, which is at the apex of the petrous portion, is six to seven millimetres. In the plate between the jugular fossa and the carotid canal

there is a very small foramen by which Jacobson's nerve, the tympanic branch of the glosso-pharyngeal nerve, passes to the tympanum through the *canalis tympanicus* (Fig. 6). In the ascending part of the carotid canal there is the minute foramen for the tympanic branch of the carotid plexus. In the jugular fossa there are a groove and a foramen for Arnold's nerve, which is the auricular branch of the pneumogastric. On the inner side of the inferior carotid foramen there is a rough free surface which is continued on to the apex of the petrous bone and forms the outer wall of the *foramen lacerum medium*. The carotid canal ascends at first perpendicularly, then turns horizontally forward and inward, and emerges at the apex of the petrous portion close to the anterior margin of the bone. It transmits the internal carotid artery.

The *posterior surface* (Fig. 2) looks backward and inward, and forms part of the posterior fossa of the base of the skull. The *internal auditory meatus*, in about the centre of this surface, is a large orifice leading into a short canal. The canal is terminated by a plate of bone called the *lamina cribrosa*, because of the many apertures for the division of the auditory nerve. In the upper anterior part of the posterior surface is a larger opening, the upper end of the *aqueduct of Fallopius*, for the facial nerve. The aqueduct goes forward and outward till it is joined by the *hiatus Fallopii*; it then turns at an angle and goes backward and outward along the upper part of the inner wall of the tympanum: here its outer and lower walls are very thin and sometimes even perforate. It then turns downward towards the stylo-mastoid foramen.

The lamina cribrosa (Fig. 10) is traversed by a horizontal ridge, the *crista falciformis*, running from the anterior wall of the internal meatus in such a way as to separate a small superior from a large inferior fossa. At the bottom of the superior fossa is a collection of minute apertures giving passage to the filaments of the superior division of the auditory nerve, and forming the *area cribrosa superior*; on the anterior wall of the fossa is the orifice of the aqueduct of Fallopius. In the inferior fossa are: 1, the *area cribrosa media*, below the hinder part of the crest, for the nerve to the saccule; 2, the *foramen singulare*, at the lower and posterior part of the fossa, for the nerve of the posterior semicircular canal; and 3, the *tractus spiralis foraminulentus*, for the cochlear division of the auditory nerve,—a series of minute holes, beginning below the area cribrosa media, forming one turn and a half in a depression corresponding to the base of the cochlea, and ending at the *foramen centrale cochleæ*, the orifice of the central canal of the modiolus.



Semi-diagrammatic view of the right internal auditory meatus of an infant, twice natural size (Quain).

The *aqueductus vestibuli* has its central orifice a little over one-half centimetre outside of the internal auditory meatus. It is a narrow fissure lying under a scale of bone. Near the upper border of the petrous portion,

between the internal meatus and the aquæductus vestibuli, there is a small foramen or fissure, which is the remnant of the large *fossa subarcuata* of the fœtus.

The *anterior* or *upper surface* (Fig. 2) of the pyramid looks upward, forward, and outward, and forms part of the middle fossa of the base of the skull. A depression near its apex lodges the *Gasserian ganglion*. From the free edge of its anterior border a narrow groove runs longitudinally outward and backward to a foramen at about the centre of this surface, called the *hiatus Fallopii*, which leads to the aqueduct of Fallopius and transmits the great superficial petrosal nerve. Parallel to this groove, and on its outer side, close to the canal for the tensor tympani muscle, there are a smaller groove and a foramen for the lesser superficial petrosal nerve. Outward and backward from these foramina there is a rounded eminence indicating the position of the superior semicircular canal.

The angle formed by the superior surface of the petrous portion and the inner surface of the squamous portion is grooved for the reception of the petro-squamosal sinus, and also shows traces of the *petro-squamosal fissure*. This fissure begins at the re-entering angle between these two portions, and can be traced less and less distinctly to the posterior border of the bone. The bone lying between this fissure, the eminence of the superior semicircular canal, and the hiatus Fallopii and groove, is a thin lamella, sometimes perforated, which rests on the mastoid antrum, the tympanum, and the canalis musculo-tubarius. The part over the mastoid antrum is called the *tegmen mastoideum*; that over the tympanum, the *tegmen tympani*. The tegmen mastoideo-tympanicum slopes forward, outward, and downward,—forward about forty-five degrees, outward about forty-five degrees, and downward from five to twenty degrees, the majority slanting about ten degrees; therefore the tegmen mastoideum is but a little higher than the tegmen tympani. These measurements of level are referred to the upper border of the zygoma and its posterior root as a horizontal line.

The following measurements of the minimum vertical distance from the upper wall of the osseous meatus to the inner surface of the tegmen tympani were taken on fifty-five macerated adult bones. The bones were levelled by placing the upper border of the zygoma and the horizontal part of the linea temporalis in a horizontal position. The place on the wall of the meatus which approached nearest the cranial cavity had no fixed position, varying between zero and six millimetres from the external orifice of the meatus, and averaging three and one-third millimetres. The thickest was nine and a half millimetres; the thinnest was two millimetres; the average was four and sixty-nine-hundredths millimetres. There were twenty measurements between four and five millimetres.

The *superior border* of the petrous bone is directed inward and forward, and slants downward. It is grooved for the superior petrosal sinus. From the inner end of this border there is often a little projecting spine overlapping the inferior petrosal sinus, which gives attachment to the petro-

sphenoidal ligament. This border is directed downward at from ten to forty-five degrees, inward at from forty to forty-five degrees, and forward at from thirty to forty degrees.

The *anterior border* of the petrous portion is shorter than the others. The inner orifice of the osseous Eustachian tube is at the angle formed by the squamous and petrous portions; and above it, and partly separated from it by a thin lamella, the *processus cochleariformis*, or septum tubæ musculo-tubariæ, is the smaller canal for the tensor tympani muscle. The direction of this common canal, the *canalis musculo-tubarius*, is outward, backward, and slightly upward.

The *posterior or inferior border* of the petrous portion internally to the jugular fossa articulates with the basilar process of the occipital bone, and forms with it the groove for the inferior petrosal sinus. Directly below the internal auditory meatus there is a three-sided depression ending in a small canal, the *aquæductus cochleæ*.

The apex of the pyramid of the petrous bone forms the outer boundary of the foramen lacerum medium, and is either grooved or perforated for the internal carotid artery where it leaves the carotid canal.

INTERNAL STRUCTURE OF THE TEMPORAL BONE.

The *tympanic cavity* is a large irregular space enclosing the auditory ossicles. The tympanic space, which is situated immediately within the membrane, should include the two extensions from the tympanum proper: these extensions are the antrum and mastoid cells posteriorly, and the Eustachian tube anteriorly; without these the tympanum would have a much smaller capacity. Its principal plane is very nearly parallel to the *membrana tympani*. For convenience the tympanum proper can be described as a hollow cube with unequal, irregular walls, and, with reference to the medial plane of the skull, as having a roof, a floor, and anterior, posterior, external, and internal walls. Its longest diameter is upward, backward, and outward, from the external opening of the osseous Eustachian tube to the mastoid antrum, or from the lower anterior to the upper posterior wall. The shortest diameter is comparatively very short, and is the line from the umbo to the promontory,



FIG. 11.
LEFT TEMPORAL BONE, HORIZONTAL SECTION, LOWER HALF (after Politzer).—*a*, anterior wall of the osseous meatus; *b*, posterior wall of same; *c*, section of the tympanic membrane, manubrium of the malleus, and posterior pouch of the tympanum; *d*, promontory; *e*, ostium tympanicum tubæ; *f*, stapes in the oval window, attached to the long process of the incus and the tendon of the stapedius muscle; *g*, mastoid process; *h*, cochlea; *k*, carotid canal; *e'*, vestibule.

going inward, upward, and backward, or from the external to the internal wall. (Figs. 11 and 12.)

According to Politzer, the measurements of the tympanum are as follows :

Immediately in front of the ostium tympanicum tubæ the height is nine to ten millimetres, and the width three to four and a half millimetres. The

widest part of the tympanum, where the upper tympanic space is largest, is fourteen to sixteen millimetres high ; immediately below the tegmen the width is six to seven millimetres ; between the incisura Rivini and the inner wall it is five to six millimetres. The most posterior part of the tympanum is fifteen millimetres high and five to six millimetres wide. The inferior wall is ten to twelve millimetres long and five millimetres wide. From the floor to the lower edge of the sulcus is two and a half to four millimetres. The anterior wall to the lower edge of the ostium tympanicum tubæ is

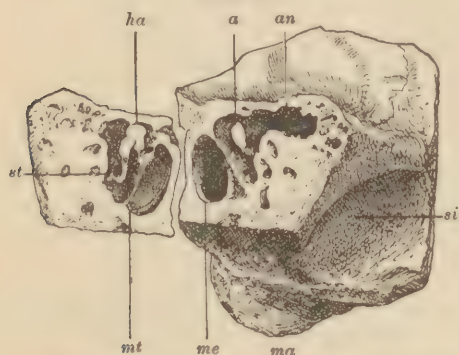
two to three millimetres, the posterior wall is seven to eight millimetres high. The opening into the mastoid antrum is five to seven millimetres high and six to seven millimetres wide.

The *roof of the tympanum*, or *tegmen tympani*, has a trabeculated concave inner surface, and is higher behind than before. The posterior half of the tegmen has a more or less regular arrangement of its trabeculæ, having a large central ridge, with laterally-radiating smaller trabeculæ and spiculæ. The anterior end of this ridge gives origin to the suspensory ligament of the malleus. This ridge, the *crista tegminis tympani*, extends backward along the tegmen mastoideum also, where it is called *crista tegminis mastoidei*, and is probably formed by the inner and inferior border of the inner table of the squamous portion, where it forms the petro-squamous suture. The tegmen tympani extends forward from the tegmen mastoideum to the roof of the Eustachian tube. Across the anterior end of the tegmen there is a thin arched lamella, with its concavity below, extending from the upper lamella of the processus cochleariformis to the spina tympani posterior, called the *crista transversa tympani*.

The *floor of the tympanum* is slightly concave, and is about four times as long as it is broad. Its surface is very irregular, and is covered with trabeculæ which have a general transverse direction, forming cells which extend for some distance, sometimes, into the surrounding bone.

The *anterior wall* is incomplete above, where the Eustachian tube has

FIG. 12.



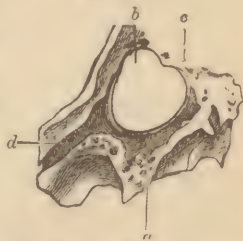
RIGHT TEMPORAL BONE, VERTICAL SECTION THROUGH THE INNER END OF THE EXTERNAL OSSEOUS MEATUS AND THE POSTERIOR PART OF THE MEMBRANA TYMPANI (after Politzer).—*me*, meatus auditorius externus; *mt*, membrana tympani; *ha*, malleo-incudal articulation, cut through; *st*, stapes; *an*, mastoid antrum; *si*, sigmoid sinus; *ma*, mastoid process.

its outer, trumpet-shaped opening, and below it is continued into the floor of the tympanum. Above the outer orifice of the Eustachian tube, and near the outer border of the anterior wall, there is a small slit, partly formed by the *suleus malleolarius*, which communicates with the fissure of Glaser and transmits the long part of the anterior ligament of the malleus, the tympanic branch of the internal maxillary artery to the fissure of Glaser, and the chorda tympani nerve. Out of this slit opens the *canal of Huguiet*, or anterior canal of the chorda tympani.

The *posterior wall* is imperfect in its upper part, where the mastoid antrum opens. The lower border of the entrance to the antrum supports the tip of the short process of the incus in a small depression, called the *sella incudis*. Slightly above the centre of the outer border this wall is pierced by a small canal which conducts the chorda tympani nerve into the tympanum and is called the *posterior canal of the cord*. This canal opens from the aqueduct of Fallopius, near the stylo-mastoid foramen, by a small orifice in the external wall of the aqueduct; the canal then goes in a direction nearly parallel to the aqueduct, but takes a position external and anterior to it. The *eminentia styloidea*, a small protuberance on the posterior wall, lies between the sinus tympanicus and the eminentia stapedis, and is, according to Politzer, the upper end of the styloid process. The posterior wall of the tympanum gradually runs into the floor, and, like the floor, is very rough, and has a number of openings of osseous cells.

The *outer wall* of the tympanum (Fig. 13) is wanting in great part, owing to the inner orifice of the external meatus, across which the membrana tympani is stretched in the fresh bone. On the adjacent sides of the lower two-thirds of this opening there is a small groove, called the *suleus tympanicus*, to which the membrana tympani is attached. Below the orifice of the meatus the outer wall is only a narrow ridge of bone; at the sides of the meatus it is even narrower; but above it the wall has a considerable surface. The outer wall which is anterior to the meatus is continued into the anterior wall of the Eustachian tube. The wall lying above the meatus is continued backward into the anterior or external wall of the mastoid antrum, and is somewhat trabeculated. At the upper part of the opening the meatus is notched slightly, forming the *incisura Rivini* (Fig. 13, *b*), which has two small angles, one anterior and one posterior. The posterior of these angles corresponds to the posterior end of the *annulus tympanicus* (Fig. 31) of early life, or *spina tympani posterior*, and the anterior angle is formed by the *spina tympani major*, from which the short part of the anterior ligament of the malleus arises. On the inner and lower side of the spina posterior the foramen of the fissure of Glaser, formed

FIG. 13.



RIGHT EXTERNAL TYMPANIC WALL, WITH THE SULCUS TYMPANICUS (after Politzer). —*a*, sulcus tympanicus; *b*, incisura Rivini, bounded in front by the spina tympani major, and behind by the spina tympani posterior; *c*, mastoid antrum; *d*, lateral wall of the Eustachian tube.

partly by the sulcus malleolarius, opens from the tympanum. The upper and lower boundaries of the canalis Glaseri are formed respectively by the crista spinarum and crista tympanica of the annulus tympanicus. They can often be made out distinctly on the adult bone. Just above the spina major there is a small concavity which receives the head of the malleus, called the *fossa capituli*.

The *inner wall* of the tympanum (Fig. 4) has a smoother surface than the other walls, and at the same time its surface is much more varied. The upper part of the surface is rough and is continued backward into the inner or posterior surface of the mastoid antrum. Where this wall joins the inner wall and floor of the mastoid antrum, just above the posterior end of the eminence formed by the aqueduct of Fallopius, there is a slight eminence formed by the anterior limb of the external semi-circular canal. Below this part of the wall there is a rounded horizontal ridge indicating the position of the aquæductus Fallopii. This ridge is called the *eminentia Fallopii*, and contains that part of the facial nerve which is directed backward. The outer wall of the aqueduct is sometimes perforated here, letting the aqueduct communicate directly with the tympanic cavity. The eminence ends in front in the *rostrum cochleare*, which is the outwardly-curved tip of the processus cochleariformis, and lies at about the upper limit of the field as viewed through the external meatus. Below the eminence is the *pelvis ovalis*, ending in the *fenestra ovalis*, which is about three millimetres long and one and a half millimetres wide, with its long axis nearly horizontal. The window is somewhat kidney-shaped, with the concavity below, and opens into the vestibule of the labyrinth. It lies nearly in the centre of the inner wall of the tympanum. Behind the pelvis ovalis is the *eminentia pyramidalis*, projecting forward. Its tip is perforated for the passage of the tendon of the stapedius muscle. The canal which lodges this muscle is at first narrow, and then dilates for the belly of the muscle. At first its direction is backward, then it curves downward, assuming nearly the direction of the descending part of the aquæductus Fallopii, on whose inner and anterior side it lies. In the lower part of their course these two canals are often confluent, or a small canal runs from one to the other conveying the nervus musculi stapedii, a branch of the facial. The length of the canalis stapedii is eight or ten millimetres. Often one or more bony spiculæ extend from the eminentia stapedii to the promontory or the borders of the pelvis rotunda. In the adult there is usually only one of these spiculæ, but the infant may have three. There is a smooth rounded projection below the oval window, which is called the *promontorium*, and which corresponds to the first turn of the cochlea. The promontory forms nearly the centre of the field when the tympanum is viewed through the external meatus. The surface of the promontory is grooved for the *tympanic plexus* of *Jacobson's nerve*, which is more rarely included in a canal. Jacobson's nerve enters the tympanum through a small canal which begins on the under surface of the petrous

portion between the carotid canal and the jugular fossa and opens on the floor of the tympanum. The posterior border of the promontory is sharply defined: here it forms the superior and anterior sides of a three-sided depression, which faces backward, outward, and downward, and is called the *pelvis rotunda*, which leads to the *fenestra rotunda*, opening into the *scala tympani cochleæ*. In the fresh specimen this fenestra is closed by the *membrana tympani secundaria*. The two borders of the *pelvis rotunda* which are formed by the promontory make nearly a right angle with each other. Owing to the direction and depth of the round pelvis, at the bottom of which the round window opens, the window is rarely visible from the external meatus. (Fig. 14.)

Looking into the pelvis of the round window inward, forward, and upward, at the extreme bottom a slit is seen, the *fissura vestibuli* of Gruber, going from below and behind forward and upward. This leads into the vestibule. The outer and upper border of the slit is formed by the *lamina spiralis ossea accessoria*, and the inner and lower border by the *lamina spiralis ossea*. In the lower part of the pelvis there is a ridge of bone convex outward and concave upward in front, and concave outward and convex upward behind. Inside the convex anterior portion, called the *crista Reissneri*, there is a passage leading to the *scala tympani*, called the *recessus anterior*. Outside the posterior concave part of the crest is the *recessus posterior*.

Occasionally one or two bony spiculæ extend from the promontory near the round window to the posterior wall. Near the posterior wall of the tympanum, and about on a level between the oval and round windows, there is a variable depression, called the *sinus tympanicus* (Fig. 33, *st*), which goes backward, downward, and inward. It sometimes communicates with the cells of the diploe in pneumatic bones. The depressions on the other walls of the tympanum, especially those on the floor, are also often found to communicate in this way. The inner wall of the tympanum is continued in front into the inner wall of the Eustachian tube.

The *osseous Eustachian tube* (Figs. 15, 16, 17, and 18) has a trumpet-shaped opening (Fig. 3, *te*) into the tympanum through the anterior wall, about midway between the floor and the roof. The tube is slightly compressed laterally and its inner end is very irregular, the posterior wall extending farther inward than the anterior wall. Politzer gives the measurements of the osseous Eustachian tube as follows: length, ten to twelve millimetres; height of middle of canal, six to seven millimetres,

FIG. 14.



RECESS OF THE RIGHT ROUND WINDOW, five times enlarged (after Gruber).—*P*, posterior part of the promontory; *t*, *t'*, *t''*, margin of pelvis of the round window; *F*, fissura vestibuli; *fr*, recessus anterior; *cp*, posterior part of the undulating margin of the round window, and below it the recessus posterior.

and width of canal below the processus cochleariformis, four to five and a half millimetres; height of ostium tympanicum tubæ, four to five and a

FIG. 15.



SECTION THROUGH THE MIDDLE PORTION OF THE RIGHT OSSEOUS EUSTACHIAN TUBE (after Politzer).—*tg*, tegmentum tympani; *tu*, transverse section of the osseous Eustachian tube; *c*, medial wall of the Eustachian tube, formed by the carotid canal; *m*, inferior lamella of the canalis tensoris tympani.

FIG. 16.



FRONTAL SECTION OF THE TEMPORAL BONE IN THE VICINITY OF THE ANTERIOR SEGMENT OF THE LOWER CONVOLUTION OF THE COCHLEA, three millimetres behind the previous section (after Politzer).—*tu*, transverse section of the osseous Eustachian tube, in the neighborhood of its tympanic orifice; *w*, inner compact wall of osseous Eustachian tube; *m*, canalis tensoris tympani; *co*, cochlea; *mi*, meatus auditorius internus; *cp*, crista petrosa.

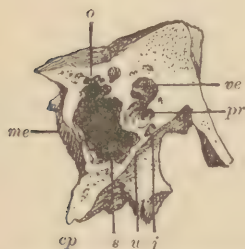
FIG. 17.



FRONTAL SECTION THREE MILLIMETRES BEHIND THE PREVIOUS ONE THROUGH THE AXIS OF THE COCHLEA (after Politzer).—*ct*, transverse section of the tympanic cavity immediately behind the tympanic end of the Eustachian tube; *m*, canalis tensoris tympani; *v*, inner compact wall of osseous Eustachian tube; *co*, cochlea; *mi*, meatus auditorius internus.

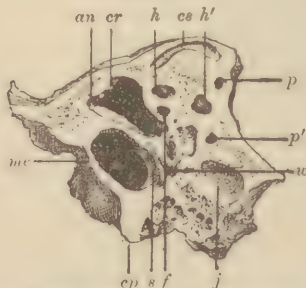
half millimetres, and width three and a half to four millimetres. Along the upper and posterior wall of the tube there runs another canal, called the *canalis tensoris tympani* (Fig. 4, *st*), which is separated from the Eustachian tube by the *septum tubæ*, so called, between the two canals. They

FIG. 18.



FRONTAL SECTION THREE MILLIMETRES BEHIND THE PREVIOUS ONE (after Politzer).—*me*, anterior wall of the external meatus; *s*, sulcus tympanicus; *o*, most anterior portion of the upper tympanic space; *u*, lower tympanic wall; *ve*, vestibule; *pr*, promontory and section of the first turn of the cochlea; *j*, jugular fossa; *cp*, crista petrosa.

FIG. 19.



FRONTAL SECTION OF THE POSTERIOR WALL OF THE TYMPANIC CAVITY (after Politzer).—*me*, external auditory meatus; *s*, lower segment of the sulcus tympanicus; *w*, posterior tympanic wall; *an*, mastoid antrum; *cr*, crista tegminis mastoidei; *cs*, superior semicircular canal; *h*, *h'*, openings of the section of the horizontal semicircular canal; *p*, *p'*, openings of the section of the posterior semicircular canal; *f*, opening of the section of the aqueduct of Fallopius; *j*, jugular fossa; *cp*, crista petrosa.

usually communicate, and thus form the *canalis musculo-tubarius*. The canal for the tensor tympani muscle goes farther backward than the Eu-

stachian tube, ending near the centre of the inner wall of the tympanum in the *rostrum cochleare*, a process directed outward nearly at right angles to the canal; it is perforated for the passage of the tendon of the tensor tympani muscle. The rostrum is just in front of the upper border of the oval window. The external and inferior wall of the tensor tympani canal, which forms a ridge along the upper and inner wall of the Eustachian tube, is called the *processus cochleariformis*, and ends in front in the rostrum cochleare. The process is sometimes dehiscence along its upper border; usually the dehiscence extends from the anterior wall of the tympanum to the tip of the rostrum. The length of the canalis tensoris tympani is twelve to fourteen millimetres. (Politzer.)

The walls of the tympanum are not infrequently encroached upon by the carotid canal and jugular fossa to such an extent that they are perforated. The usual place for the *carotid canal* to open into the tympanum is through the posterior wall of the Eustachian tube at its tympanic end, or through the anterior end of the floor of the tympanum and the lower anterior part of the inner wall. The opening, when present, is about at the angle of the carotid canal. Normally these parts of the tympanic wall are very thin.

Dr. Otto Körner found the carotid canal from 1 to 7.8 millimetres and averaging 3.23 millimetres from the sulcus tympanicus. On the left side the average was 3.08 millimetres and on the right 3.14, the greatest difference being 2.8 millimetres between the two sides.

The *jugular fossa* less often communicates with the tympanic cavity through the plate of bone separating the fossa and the lower posterior part of the tympanum, which is usually thin. When this dehiscence occurs, it is usually about where the inner and posterior walls join the floor of the tympanum.

The *auditory ossicles* lie in the tympanic cavity, and are three in number, beginning with the outermost,—malleus, incus, and stapes.

The *malleus* (Figs. 20 and 21) is made up of a head, neck, and three processes,—viz., the manubrium, the processus gracilis, and the processus brevis. The malleus is about nine millimetres long, the manubrium four to five millimetres (Burnett). The *head* of the malleus is the large rounded upper extremity which in the normal position lies above the margin of the incisura Rivini, and is out of sight. On its anterior surface there is a well-marked depression for the attachment of the anterior ligament of the malleus. On the posterior aspect of the head there is a concavo-convex articular facet with prominent margins for articulation with the incus. The facet extends in an oblique direction from above inward and downward, and is formed by two oblique planes meeting in a nearly vertical line. The lower or inner plane is called the cog of the malleus. The head is continued into the neck, which is flattened laterally and has an inner and an outer rhomboidal surface; the neck is continued into the manubrium. The head and neck form an angle with the manubrium of about one hundred and fifty degrees, which opens towards the tympanic

cavity. At the apex of this angle, on the outer side of the bone, there is the *short process* of the malleus. The *processus gracilis* arises from the anterior border of the neck at the anterior angle of the rhomboidal surface. It is a comparatively long and slender lamella of bone, slightly curved, and is

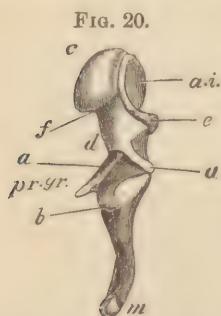


FIG. 20.
LEFT MALLEUS OF AN ADULT, VIEWED FROM THE OUTER SIDE, magnified four times (Quain, after Helmholtz). —c, capitulum; a.i., grooved articular surface for the incus; e, its prominent lower margin or cog; d, neck; m, end of manubrium; b, short process; pr.gr., processus gracilis; a, ridge for the external ligament; f, upper limit of the attachment of the anterior ligament.

directed forward, lying in the sulcus malleolarius of the annulus tympanicus. This process was formerly supposed to become atrophied in the adult, leaving only a stump for the attachment of the long part of the anterior ligament of the malleus; but this is not the case, as was suggested by Randall, and it is unusual for it to take place.

The outer rhomboidal surface of the neck forms the inner wall of Prussak's chamber. A strongly-

marked ridge forms the upper posterior border of this surface, going from the lower internal anterior border of the head to the posterior angle of the rhomboidal surface. It is called the *crista colli*, and the external ligament of the malleus is attached to it.

The *manubrium* of the malleus is a plate of bone extending down from the neck. It has two principal surfaces, triangular in shape, with their bases above. One of these surfaces looks forward and inward, and the other backward and outward. The outer borders of these surfaces are concave and the inner convex. The *membrana tympani* is attached to the outer borders, while the inner borders are free and diverge at their upper ends, forming the two lower sides of the internal rhomboidal surface of the neck. The third or upper borders of the triangular surfaces are much shorter than the others. The outer and inner borders meet at the lower extremity of the handle, or *umbo*. The *umbo* is somewhat flattened parallel to the *membrana tympani*, while higher up the manubrium is flattened at right angles to the *membrana*. The upper and outer borders unite in forming the short process of the malleus, while the upper and inner borders are continued into the external and internal surfaces of the neck. The lower third of the manubrium is curved slightly forward and the short process curves slightly backward, thus giving to the external surface of the manubrium an S-shaped curve.

The *incus* (Fig 22) consists of a body and two processes. Through the long process it measures seven millimetres. The upper edge of the bone

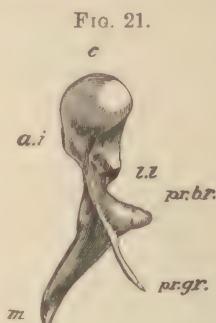


FIG. 21.
LEFT MALLEUS OF A CHILD, VIEWED FROM IN FRONT, magnified four times (after Quain). —c, head; a.i., articular surface of the incus; l.l., neck; pr.br., short process; m, tip of manubrium; pr.gr., processus gracilis.

is five millimetres long, and its greatest thickness is two and one-half millimetres (Burnett).

The *body* resembles a bicuspid tooth somewhat flattened laterally, the two processes corresponding to the fangs of the tooth, and the superior and inferior odontoid processes of the incus corresponding to the cusps. The articular surface for the malleus is concavo-convex, and covers the lower odontoid process and the lower external half of the superior odontoid process; it is surrounded by a raised border. The articular surfaces of the two odontoid processes form nearly a right angle with each other, the angle running in a nearly vertical direction and receiving the ridge of the articular facet of the malleus. The lower odontoid process, or *cog*, of the incus articulates with the cog of the malleus, and its articular surface looks outward. The articular facet of the superior odontoid process looks forward, and is slightly convex from without inward to fit the corresponding concave part of the facet on the malleus. The upper posterior part of the superior odontoid process is called the *crest*. The *short process* of the incus is directed backward from the body. It is conical and compressed laterally. Its apex articulates with the posterior wall of the tympanum in a depression called the *sella incudis*, situated near the lower margin of the mastoid antrum. The tip of the process is usually marked for the insertion of the posterior ligament of the incus. The *long process* of the incus is

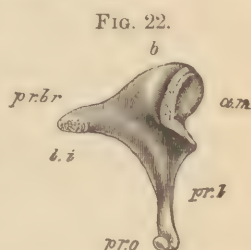


FIG. 22.
LEFT INCUS, VIEWED FROM THE INNER SIDE AND SOMEWHAT FROM BEFORE, magnified four diameters (after Quain).—*b*, body; *a.m.*, articular surface; *pr.br.*, short process; *l.i.*, rough surface for the attachment of the posterior ligament; *pr.l.*, long process, ending in the *pr.o.*, processus lenticularis.

directed downward from the body, forming a rounded right angle with the short process; it is slightly flattened from before backward, and is much more slender than the short process. It gradually tapers to its tip, which is cylindrical and more or less sharply curved inward, nearly at a right angle. When in position, the direction of the short process of the incus is nearly parallel to the manubrium of the malleus. Just at the tip of the short process there is a narrow constriction, and the bone ends in a thin disk, facing inward, called the *processus lenticularis*, which articulates with the capitulum of the stapes. The inner surface of the lenticular process is slightly convex, for articulation with the concave head of the stapes.

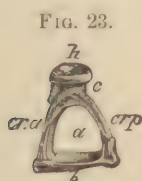


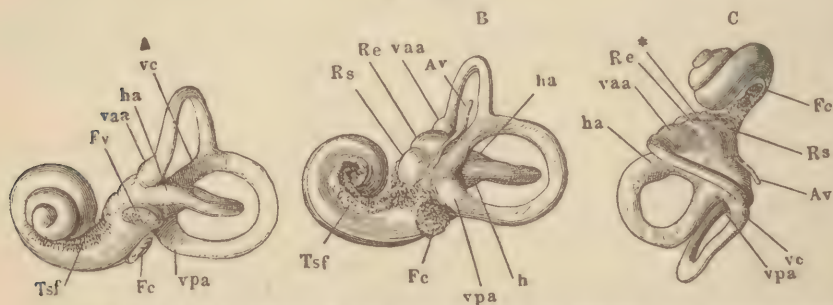
FIG. 23.
LEFT STAPES, VIEWED FROM BELOW, magnified four diameters (after Quain).—*h*, outer extremity or head of the bone, with a shallow concavity for articulation with the lenticular process of the incus; *c*, constricted part of cervix: it is not always as well marked as this; *cr.a.*, anterior crus; *cr.p.*, posterior crus; *b*, foot-plate; *a*, arch of the stapes, across which the *membrana propria* lies; the groove of the crura is seen in front and below.

The *stapes* (Fig. 23) is composed of a foot-plate, two crura, and a head. It is nearly four millimetres from the head to the foot-plate. The foot-plate is two and one-half millimetres long and

one millimetre wide, and about one-quarter millimetre thick on the edge (Burnett). The *foot-plate* is kidney-shaped, with the concave edge downward. It is thinner at the centre than at the edges, is slightly concave on its tympanic surface and convex on its vestibular surface, and articulates with the margins of the fenestra ovalis. It is nearer the lower wall of the pelvis ovalis because the wall on that side is more abrupt than the other.

The two *crura*, one anterior and one posterior, curving towards each other, together form an arch. The curvature increases as they approach, and by their union they form the head of the stapes. The crura are much narrower than the foot-plate, and arise from it a short distance from its ends. In the anterior or posterior aspect the crura do not make a perfect right angle with the foot-plate, but are tilted either upward or downward. On cross-section the crura are U-shaped, with the concavity of the U directed towards the opposite crus; the lower limb of the U is oftentimes more elongated than the upper. The edges of the U give attachment to the double interosseous membrane, which is sometimes found perfect. The

FIG. 24.



CORROSION CASTS OF THE LABYRINTH (after Helmholtz).—A, left labyrinth from without; B, right labyrinth from within; C, left labyrinth from above; *Fv*, fenestra rotunda; *Fe*, fenestra ovalis; *Re*, recessus hemi-ellipticus; *Rs*, recessus hemisphaericus; *h*, horizontal semicircular canal; *ha*, ampulla of the horizontal semicircular canal; *vaa*, ampulla of the superior semicircular canal; *vpa*, ampulla of the posterior semicircular canal; *vc*, common limb of the superior and posterior semicircular canals; *Av*, aqueductus vestibuli; *Tsf*, foramina for the cochlear nerve; *, canals for the vestibular nerve.

anterior crus is straighter than the posterior, and also leaves the foot-plate more obliquely than the other. The posterior crus is usually broader and deeper than the anterior. The neck, where the crura meet, is flattened from above downward, and sometimes slightly constricted. The head, becoming more nearly cylindrical, is slightly expanded towards its articular surface.

The outer or articular surface of the stapes articulates with the incus, and is slightly concave. Its plane runs downward and inward, being oblique to the direction of the crura.

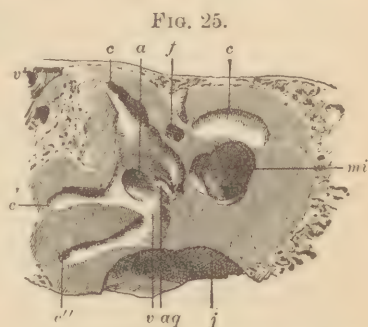
The *osseous labyrinth* (Figs. 3, 7, 8, 11, 12, 19, 25, 26, and 34) contains the membranous labyrinth, and consists of three parts,—the vestibule, semicircular canals, and cochlea,—and is formed by a series of cavities in the hardest part of the petrous bone. These communicate with each other and with the surface of the petrous bone through the cribriform plate and

the aqueducts of the cochlea and vestibule, and with the tympanum through the fenestræ.

The *vestibule* is the common central cavity. Its inner wall lies against the peripheral end of the meatus internus and the outer wall surrounds the fenestra ovalis. It lies behind the cochlea and in front of the semicircular canals. It is flattened from without inward and is ovoid from before backward. On its outer wall there is the fenestra ovalis. On the inner wall, anteriorly, there is a small circular depression, called the *fovea hemisphærica*, which is perforated anteriorly and inferiorly by minute foramina for the passage of branches of the auditory nerve. This part is called the *macula cribrosa*. Behind the fossa there is a vertical ridge, called the *crista vestibuli*. Inferiorly, the crest divides into two branches, and is gradually lost in the inner wall. Posteriorly, on the inner wall there is the orifice of the aquæductus vestibuli. On the upper wall there is an oval depression, lying transversely, and called the *fovea hemi-elliptica*; between this and the fovea hemisphærica there is a slight elevation, called the *pyramidal eminence*. Between the limbs of the fork of the crista vestibuli there is a third much smaller depression, called the *recessus cochlearis*. Posteriorly, these are the orifices of the semicircular canals, five in all, one of them being common to two canals. Anteriorly, there is a large oval opening going into the scala vestibuli of the cochlea, through the so-called *apertura sceale vestibularis cochleæ*.

The *semicircular canals*, three in number, are situated above and behind the vestibule. They describe nearly a whole circle, are slightly flattened laterally, and are of different lengths. They are about one millimetre in diameter, except at one extremity, where they enlarge to about two and a half millimetres; this circular enlargement is called the *ampulla*. The length and diameter of the canals increase constantly in the later years of life. The superior canal of one side and the posterior of the other lie in parallel planes, while the external canals are in the same plane. Each canal lies at right angles to the other two.

The *superior semicircular canal* is vertical, and lies under the eminence of the superior semicircular canal on the anterior surface of the petrous bone, at right angles to the posterior surface of the bone. Its anterior end is furnished with an ampulla, and opens directly from the upper posterior part of the vestibule; its posterior end unites with the end of the posterior



SAGITTAL SECTION THROUGH THE LONG AXIS OF THE PYRAMID; VIEW OF THE INNER SURFACE OF THE CUT (after Politzer).—*v*, inner wall of the vestibule with the recessus hemi-ellipticus; *aq*, vestibular opening of the aqueduct of the vestibule, with its furrow-shaped continuation downward on the inner vestibular wall; *f*, section of the aqueduct of Fallopius; *j*, fossa jugularis; *c, c', c''*, segments of the sections through the osseous semicircular canals; *a*, opening of the canalis communis; *mi*, section of the meatus auditorius internus; *c*, (front) portion of the lower convolution of the cochlea.

canal which has no ampulla, and by a common orifice they open into the posterior part of the vestibule. The superior canal is about twenty millimetres long.

The *posterior semicircular canal* is vertical, and lies nearly parallel to the posterior surface of the petrous bone, extending outward and backward from the vestibule. The end having the ampulla opens from the lower posterior part of the vestibule; the other end opening, in common with the superior canal, from the posterior part of the vestibule. It is about twenty-two millimetres long.

The *external semicircular canal* is nearly horizontal, and extends outward and backward from the vestibule. Its ampulla opens from the upper and outer angle of the vestibule, just above the fenestra ovalis; the other end opens from the upper posterior part of the vestibule. This canal is about fifteen millimetres long.

Dr. Otto Körner finds the external semicircular canal is on the average six and one-tenth millimetres from, and somewhat lower than, the sulcus tympanicus.

In the description of the cochlea the terms internal and external, or central and peripheral, and superior and inferior, refer to the pyramid of the cochlea as a whole, and not to the rest of the body.

The *cochlea* (Fig. 26), so called from its resemblance to a snail-shell,

forms the anterior part of the labyrinth, the promontory forming its external wall. It is conical, with a nearly horizontal axis, the apex pointing forward and outward towards the superior anterior wall of the tympanum; the base lies on the anterior depression at the bottom of the internal meatus and is perforated by many fine apertures for the cochlear branch of the auditory nerve. The height and the breadth of the base of the pyramid are nearly equal, being from four to five millimetres. It consists of a conical central axis, called the *modiolus*, and a canal wound round this axis, called the *cochlear canal*.

The modiolus extends from the base to the apex of the cochlea. It is conical, with a broad base, which corresponds to the first turn of the cochlea, and it is perforated for the passage of the nerve-filaments. The modiolus diminishes rapidly in size for the second coil, and terminates in the last half-coil, or cupola, in a delicate expanded lamella, shaped a little like the half of a funnel, and is called the *infundibulum* or *lamina modioli*, which forms the inner boundary of the helicotrema. The broad part of the infundibulum is directed towards the apex of the cochlea, and forms part of the cupola. The outer surface of the modiolus forms the inner wall of the cochlear canal. Its central part is channelled by canals for the nerve-filaments which radiate

FIG. 26.



SECTION THROUGH THE OSSICULAR CAPSULE AND THE MODIOLUS OF THE COCHLEA, WITH THE LAMINA SPIRALIS OSSEA (after Politzer).—a, internal auditory canal; b, modiolus.

out into the lamina spiralis. The central canal of the modiolus is larger than the others: it extends from the base to the infundibulum, and contains the nerve and the artery of the modiolus. The modiolus has another large canal near the line of attachment of the lamina spiralis, which is called the *canalis spiralis modioli*. It has a very irregular lumen, and is partly divided horizontally. The walls of the canalis spiralis are perforated by many small canals, transmitting vessels and nerves from the centre to the lamina spiralis.

The canal of the cochlea makes from two and a half to two and three-quarters turns around the modiolus, and it is from twenty-eight to thirty millimetres long. It diminishes gradually in size from the base to the apex, where it terminates in a cul-de-sac, called the *cupola*, which forms the apex of the cochlea. The width of the two extremities of the canal is slightly greater than the height, and in the central portion the height is greater than the width. The lower end of the canal is about two millimetres in diameter at right angles to the modiolus, and it diverges from the modiolus towards the vestibule and tympanum. It has three openings: the fenestra rotunda, communicating with the tympanum; the apertura scalæ, opening into the vestibule; and the foramen of the aquæductus cochleæ, opening on the posterior inferior border of the petrous bone. From the point where the canal of the cochlea first commences to coil upon itself, the upper wall of each underlying coil is united with the under wall of the coil immediately above it, thus forming a spiral partition which becomes thinner towards the cupola. This partition-wall is at first about at right angles to the modiolus, but it becomes tilted towards the apex, when the angle it forms is much less than a right angle. The coils of the cochlear canal are called apex, central, and basilar.

The lamina spiralis partly divides the cochlear canal into an upper tube called the *scala vestibuli*, opening into the vestibule, and a lower tube called the *scala tympani*, which does not open into the vestibule, but communicates with the tympanum through the round window. It is attached to the whole length of the modiolar wall of the canal, and projects about half-way across the canal towards the outer wall. In the basilar coil the lamina is at about right angles to the modiolus, but this angle diminishes constantly towards the top, where it is less than forty-five degrees; also, in the basal coil the lamina is nearer the roof of the canal, but it gradually falls in the canal till at the summit it is nearer the floor; thus the lower end of the scala tympani is deeper than the scala vestibuli, and the upper end of the scala vestibuli is deeper than the scala tympani. The beginning of the lamina spiralis is a semilunar crest which stretches towards the fenestra rotunda.

The upper end of the lamina has a free upper border which is concave, thus forming a hooked process at the junction of the outer and upper borders. This process is called the *hamulus Scarpæ*, and it forms the outer boundary of the helicotrema.

The outer border of the lamina spiralis is unevenly serrated and grooved longitudinally, forming the *sulcus spiralis*. To this border the membrana basilaris is attached. The lamina spiralis consists of two very thin lamellæ connected by vertical ridges, between which there are numerous canals for the filaments of the cochlear nerve and vessels going from the canalis spiralis to the organ of Corti.

The *lamina spiralis accessoria* is a narrow lamina projecting inward towards the lamina spiralis from the outer wall of the first part of the basilar coil. It is broadest where it commences at the base, and gradually narrows to nothing. A little farther from the base, but close to the fenestra rotunda, and in the outer wall of the canal of the cochlea, there is the small inner orifice of the aquæductus cochleæ.

DEVELOPMENT OF THE TEMPORAL BONE.

The temporal bone is developed from ten bones and two cavities. The cavities are the first visceral cleft and the sac of invaginated epiblast. The bones are the squama; the tympanic; the proötic, epiotic, and episthotic, uniting to form the petro-mastoid; the three ossicles, malleus, incus, and stapes; and the tympano-hyal and stylo-hyal, uniting to form the styloid process.

The temporal bone in the later stages of fœtal life consists of three principal pieces, the squamous, petro-mastoid, and tympanic (Fig. 27).

All the parts of the membranous labyrinth, when first formed, are simple epithelial tubes embedded in embryonic connective tissue.

These tubes are originally formed from a single invagination of the cutaneous epiblast. The Eustachian tube, with the tympanic cavity, and the external auditory canal, with the pinna, are formed from the first visceral cleft, and from the parts of the mandibular and hyoidean arches which immediately surround the cleft. The membrana tympani is early formed by a constriction close to the external opening of the cleft, which finally closes it. The tympanic cavity does not properly exist till air enters

through the Eustachian tube after birth. The external ear is early formed about the margins of the shallow meatus.

The malleus is developed from the proximal end of the first or mandibular arch, and is homologous to the quadrate bone of reptiles and birds.

FIG. 27.



LEFT TEMPORAL BONE OF AN INFANT, FROM THE OUTER SIDE (after Gruber).—s, squama; fms, fms', fissura mastoidea squamosa; fg, fissura Glaseri; fsm, stylo-mastoid foramen. The annulus tympanicus lies between fg and fsm.

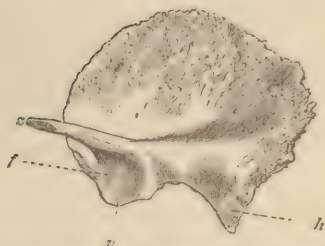
The incus is developed from the proximal end of the hyoidean or second visceral arch.

The stapes is formed in the connection of the fenestra ovalis and hyoidean arch.

The *squamous portion* is ossified in membrane from a single nucleus, which appears low down about the seventh or eighth week and extends upward. From the hinder part of the squamous a considerable post-auditory process grows downward below the supra-mastoid crest, separating the tympanic from the petro-mastoid, and forming the upper and anterior part of the mastoid portion. Enclosed between this and the petro-mastoid portion there is a space continued backward from the tympanum, which is the mastoid antrum, from which the mastoid cells subsequently grow out.

The squamous portion (Figs. 28 and 29) at birth can be readily detached from the other portions of the temporal bone. The outer and inner tables of the bone are separated at an angle along the lower border. The surface between the edges of the separated tables is rough and trabeculated, and forms part of the upper and outer wall of the tympanic cavity and mastoid

FIG. 28.



LEFT SQUAMOUS PORTION OF THE TEMPORAL BONE OF AN INFANT, SEEN FROM WITHOUT (after Gruber).—*z*, zygomatic process; *f*, glenoid fossa; *v*, anterior inferior process of the external plate; *h*, posterior inferior process of the external plate of the bone.

FIG. 29.



LEFT SQUAMOUS PORTION OF THE TEMPORAL BONE OF AN INFANT, VIEWED FROM WITHIN (after Gruber).—*p*, cerebral surface of vertical plate; *i*, internal plate of the bone; *a*, external plate of the bone; *z*, posterior part of the angle between the two plates.

antrum. The inner table joins the petrous portion by means of the petro-squamous suture, and helps form the tegmen tympani. The outer tube is more extensive than the inner after their separation. It continues downward and inward. Anteriorly, it forms the outer part of the wall of the tympanum; posteriorly, it forms the upper part of the outer posterior wall of the tympanum and the outer wall of the mastoid antrum. Its lower border is indented by the notch of Rivinus and the superior half of the inner end of the meatus. At the junction of the anterior and lower borders there is a small projecting angle to which the anterior end of the annulus tympanicus is attached. At the junction of the lower and posterior borders there is a long process—the *processus squamo-mastoideus*—which supports the posterior end of the annulus tympanicus and extends downward and inward to the stylo-mastoid foramen. The posterior border joins the

mastoid portion of the petro-mastoid bone, thus forming the mastoideo-squamous suture. This part of the squama assists in the formation of the mastoid cells, and is described as the *os epitympanicum*, which is said to exist as a separate little plate until the second month of foetal life. This outer plate acts an important part in the further development of the temporal bone. Its lower border, or the part extending between the tips of the annulus tympanicus, grows nearly horizontally, and forms the upper wall of the external osseous auditory meatus, called the auditory plate. The posterior border, bounded by the mastoideo-squamous suture, develops downward and backward, forming the anterior and greater part of the external wall of the mastoid process. The mastoideo-squamous suture in the adult, when it can be traced, goes from the re-entering angle between the upper surfaces of the mastoid and squamous portions nearly to the tip of the mastoid process, and, rounding upward, inward, and forward, ends in the stylo-mastoid foramen.

The ossification of the tympanic ring begins during the third month by the appearance of an osseous nucleus, which extends upward in the external membranous wall of the tympanum. At birth the extremities of the annulus have united to the squama.

The *annulus tympanicus*, at birth, is a slender ring of bone, imperfect in its upper eighth. Along the concave side there is a small groove, called the *sulcus tympanicus*, for the attachment of the *membrana tympani*. The outer surface (Fig. 30) of the ring has two small enlargements, one on the anterior arm of the U, slightly above its middle, corresponding to the *spina tympanica anterior*, which is on the inner side of the annulus, and called the *anterior tympanic tubercle*. The other small tubercle is on the posterior arm, slightly below its centre, and is called the *posterior tympanic tubercle*. From these tubercles the ossification starts which finally forms the tympanic plate.

FIG. 30.



OUTER SIDE OF THE
ANNULUS TYMPANICUS,
LEFT EAR (after Po-
litzer).—*a*, tuberculum
tympani anterior; *p*,
tuberculum tympani
posterior.

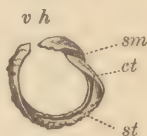
On the anterior arm, a short distance below the anterior tubercle, there is a slight projection forward, called the *spina tympani inferior*. The inner surface (Fig. 31) of the anterior arm of the annulus has a small spine pointing backward and inward from near the tip of the posterior border; this is called the *spina tympani major*. Above this spine the posterior border is concave, forming the anterior end of the *incisura Rivini* and lodging the head of the malleus. From the anterior border, a little below the *spina major*, there is another spine pointing forward and outward, called the *spina tympani anterior*. Connecting these two spines is a ridge, called the *crista spinarum*. Below the centre of the anterior border of the inner surface of the anterior arm of the annulus there is a spine directed forward and inward, which is called the *spina tympani inferior*. There is a sharp ridge connecting the *spina major* and *inferior*, called the *crista tympanica*. The upper half of this crest forms part of the posterior

border of the inner surface of the anterior limb of the annulus. Between the crista spinarum and the crista tympanica there is a trough, called the *sulcus malleolaris*, which lodges the part of the anterior ligament of the malleus not attached to the spina tympani posterior, the *processus gracilis*, the tympanic branch of the internal maxillary artery, and at first the chorda tympani nerve, and forms the anterior boundary of the fissure of Glaser.

The inner surface of the posterior arm of the annulus, a little below its middle, shows the enlargement called the *posterior tympanic tubercle*. The anterior border of the tip of this surface is slightly projecting, and is called the *spina tympani posterior*, which forms the posterior angle of the incisura Rivini and gives attachment to the posterior ligament of the malleus. It extends internally and anteriorly to the *sulcus tympanicus*. The tubercles of the annulus increase in size and meet on the plane of the meatus during the second year, enclosing a foramen on their inner borders called the *canal of Huschke*, which gradually closes and is generally obliterated after the fifth year, although it is not infrequently present throughout life. Its former portion is usually indicated by a thin spot in the tympanic plate. At birth the *membrana tympani* and *annulus tympanicus* are even with the outer surface of the bone; the *glenoid fossa* is shallow, and the *articular eminence* is not marked.

The external auditory meatus (Fig. 27), at birth, is not closed by agglutination of its walls, as in the young of some of the lower mammals, but there is a simple coaptation, the *membrana tympani* lying upon the inferior wall. The lumen or air-space of the meatus is subsequently developed, and at first has the form of two funnels joined at their apices, the narrow part corresponding to the isthmus of the adult. As the tympanic plate develops outward along the floor of the meatus, it also develops along the anterior and posterior walls, leaving a space on the superior and superior posterior walls which is completed by the horizontal plate of the squama. The superior and superior posterior walls of the external osseous meatus are formed by outward growth of the squama. At twelve months the size of the osseous meatus is about half that of the adult, while the anterior inferior and inferior walls of the meatus are at first formed by fibrous tissue, and later on by the tympanic plate. At birth half the whole meatus is membranous and the rest is cartilaginous; the cartilaginous external auditory meatus consists of two or three segments which subsequently become only imperfectly united, leaving the fissures of Santorini. The crista spinarum and the lower half of the crista tympanica unite later on with the tegmen tympani, which comes down to meet them and draws nearer and nearer to the anterior

FIG. 31.

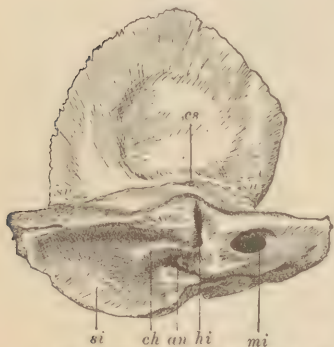


LEFT TYMPANIC RING OF AN INFANT, VIEWED FROM WITHIN (after Gruber).—*h*, anterior extremity of the ring, and just below it is the *spina tympani major*; *sm*, *spina tympani anterior*, and between *sm* and *h* is the *crista spinarum*; *ct*, the *crista tympanica*, ending below and in front in the *spina tympani inferior*, and above and behind in the *spina tympani major*; between the crests lies the *sulcus malleolaris*; *v*, posterior extremity of the ring, forming anteriorly the *spina tympani posterior*.

process of the lower margin of the squama, so separating the fissure of Glaser from the canalis musculo-tubarius, which first communicated, and also narrowing the disproportionately wide fissure of Glaser of the infant. Both the crista spinarum and this part of the tegmen grow downward with the subsequent growth of the bone, the tegmen forming the anterior wall of the canalis musculo-tubarius and the posterior wall of the fissure of Glaser. Occasionally a continuation of the fissure of Glaser persists externally to the crista spinarum, when the crista may or may not be united to the descending process of the tegmen tympani.

Petro-mastoid (Fig. 32).—Ossification of the cartilaginous ear-capsule begins in the latter half of the fifth month, and by the end of the sixth month the various centres are united. The

FIG. 32.



LEFT TEMPORAL BONE OF A NEW-BORN INFANT, VIEWED FROM THE INNER SIDE (after Politzer).—*su, su'*, petro-squamosal suture; *ca*, tegmen tympani; *mi*, meatus auditorius internus; *hi*, fossa subarcuata; *an*, fissure of the aqueduct of the vestibule; *ch*, elevation made by the horizontal semicircular canal; *si*, position of the sinus sigmoideus.

first centre of ossification to form is one on the promontory, called *opisthotic*; this surrounds the round window and forms the bone below the oval window and internal meatus. The second centre, called *proötic*, begins over the superior semicircular canal and forms most of the surface of the petrous, the upper and inner half of the mastoid portion, and the upper part of the oval window and internal meatus. The next nucleus to appear is called *epiötic*; it is near the posterior semicircular canal and forms the lower part of the mastoid. According to Sutton, the covering of the semicircular canals and tegmen tympani is formed from a separate centre called the *pteroötic*, which appears at about the same time as the *proötic*. Vrolik describes a separate centre for the roof of

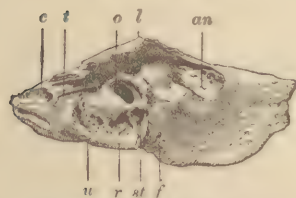
the cochlea, and one near the common portion of the superior and posterior semicircular canals. On the upper central part of the posterior surface of the petrous portion, at birth, there is a considerable depression directed outward under the arch of the superior semicircular canal; this is called the *fossa subarcuata*, and is probably homologous to the floccular fossa of the lower animals. There is usually a trace of this fossa persisting in the adult as a small fissure above and external to the internal meatus. Both the aqueducts of the vestibule and cochlea open about the centre of the posterior surface of the petro-mastoid portion, being separated only by a thin lamella. At birth the petro-mastoid is still separated from the squama by a cartilaginous plate, but before the end of the first year the bones are united.

At birth the inner wall of the tympanum (Figs. 33 and 34), near its posterior margin, has a conical depression between the levels of the oval and round windows, called the *sinus tympanicus*. It is not so well marked

in the adult. On this wall, at birth, there are usually two and sometimes three bony spiculæ in the vicinity of the oval window, but more often only one is left in the adult bone.

The development of the mastoid process begins about the second year. It starts at the antero-inferior part of the mastoideo-squamosal fissure, and is derived not only from the mastoid portion of the petro-mastoid bone, but also from the processus squamo-mastoideus. The position of the fissura mastoideo-squamosa can be traced in many adult temporal bones, either as a fissure running in a more or less zigzag line from above and behind downward and forward, or as a series of small linear clefts or small foramina arranged in line, or by an irregular line which separates the smooth anterior squamous part from the rough posterior petro-mastoid

FIG. 33.



PETROSAL PORTION OF THE LEFT EAR OF A NEW-BORN INFANT, LOOKING INWARD AFTER REMOVAL OF THE SQUAMOUS PORTION AND THE ANNULUS TYMPANICUS (after Politzer).—*o*, fenestra ovalis; *r*, fenestra rotunda; *st*, sinus tympanicus; *u*, outer border of the lower surface of the pyramid; *f*, stylo-mastoid foramen; *l*, lamella of the tegmen tympani; *an*, mastoid antrum; *t*, ostium tympanicum tubæ Eustachii; *c*, carotid canal.

FIG. 34.



HORIZONTAL SECTION OF THE LEFT PETROSAL BONE OF A NEW-BORN INFANT, UPPER HALF; twice natural size (after Politzer).—*a*, vestibule; *b*, base of cochlea; *c*, cupola; *d*, *d'*, section of the superior semicircular canal; *e*, internal osseous meatus; *f*, stapes; *g*, mastoid antrum.

part. Kiesselbach states that this fissure is open in three per cent. of the bones he examined. The mastoid processes with a well-marked fissure are found to be proportionately flatter laterally than others. Together with the growth of the mastoid process, its cellular spaces are developed. The cells increase partly on the inner side of the antrum by the enlargement of the diploëtic spaces, and partly from the cellular spaces of the posterior part of the angle between the tables of the squama, but chiefly in the mastoid portion as it grows longer. From this it is evident that the cells are arranged in two sets, the superior or central and the inferior or peripheral. Together with the development of the cells of the mastoid, the walls become thinner, especially on the inner side in the groove of the sigmoid sinus. This groove is not present on the bone of the child, but becomes developed in company with the cells of the mastoid. The porous structure of the walls of the mastoid portion of the child persists to some extent in the adult, where there are many canals of different sizes transmitting blood-vessels and connective tissue to the interior. In the new-born infant the antrum of the mastoid is about five millimetres long and

four millimetres wide, and its walls are made of spongy bone containing small cellular spaces. The full development of the mastoid portion is only completed at puberty, together with the other air-sinuses of the cranium.

The *styloid process* is formed by the union of two bones; the tympanohyal is next to the incus in the hyoidean or second visceral arch; this ossifies before birth into the tympanic plate, and is surrounded by the vaginal process. The style of the styloid process is formed by the stylohyal, which is the third bone from the proximal end of the hyoidean arch. This ossifies after birth usually, but does not join the tympanohyal till after adult life, and frequently it remains a separate bone through life.

After puberty, with this exception, the temporal bone has completed its adult development.

THE FRESH HUMAN TEMPORAL BONE.

In the recent state the outer surface of the squamous portion is covered by the temporal muscle, and the lower surface of the zygoma gives attachment to the masseter muscle. The greater part of the glenoid fossa is filled by the parotid gland, the anterior part and the articular eminence being in contact with the interarticular fibro-cartilage of the lower jaw. The under surface of the petrous portion lies deep at the base of the skull and gives attachment to fascia, and anteriorly to the levator and tensor palati muscles. From the styloid process the stylo-glossus, stylo-hyoid, and stylo-pharyngeus muscles arise. The posterior and lower part of the mastoid portion gives attachment from above downward and from before backward to the muscles *retrahens aurem*, *occipito-frontalis*, *sterno-mastoid*, *splenius capitis*, *tracheo-mastoid*, and *digastric*. The rest of the outer surface of the bone, the zygoma and the upper part of the mastoid portion, is subcutaneous. The inner surface of the squamous and mastoid portions and the superior and posterior surfaces of the petrous portion are covered by *dura mater*.

The *fasciæ* lying in the vicinity of the under side of the petrous pyramid and mastoid region are the prevertebral fascia and the sheaths of the muscles and parotid gland. Except for these, there is no particular check offered to the burrowing of pus in any direction inside of the deep layers of fascia connecting the superficial muscles of the neck.

The cranial surface of the squamous and the superior surface of the petrous portion lie against the temporo-sphenoidal lobe of the cerebrum; the outer half of the posterior surface of the petrous portion and the inner side of the mastoid portion are against the cerebellum. The inner half of the posterior surface of the pyramid lies against the peduncle of the cerebrum. At the inner end of the superior surface of the petrous portion the Gasserian ganglion lies in its shallow depression.

The *gyrus inferior* lies along the angle of the petrous and squamous portions. Over the tympanum is the *gyrus fusiformis*. The *gyrus hippo-*

campi lies towards the inner end of the pyramid. The parotid gland rests against the inferior and anterior surface of the external meatus and in the posterior half of the glenoid fossa.

THE EXTERNAL EAR.

The external ear consists of the *auricle*, or *pinna*, and the *external auditory meatus*. (Fig. 35.)

The *auricle*, or *pinna*, is the most external part of the organ of hearing, and is composed of a cartilage covered with skin. The cartilage is continuous with the cartilaginous meatus. It is attached to the side of the head at the apex of the mastoideo-mandibular fossa, between the head of the jaw and the mastoid process. The cartilage of the pinna usually projects backward from the skull at an angle of from thirty-five to forty degrees. At the upper end this angle decreases sometimes to ten degrees, and in rare cases the upper border of the auricle is attached to the head, leaving only the lower part free, which then makes a much smaller angle than usual with the side of the head.

Of the two surfaces of the pinna the anterior looks somewhat forward and is concave; the posterior looks backward and is convex. Each exhibits elevations and depressions so arranged that an elevation on one surface has its corresponding depression on the other. These corresponding elevations and depressions have received corresponding names. The pinna is ovoid with the greater end uppermost. The external prominent rim of the auricle is called the *helix*. Another curved prominence, parallel with and in front of the helix, is the *antihelix*; this bifurcates above into the *crura of the antihelix*, so as to enclose a triangular depression, the *fossa intercruralis*. The narrow curved depression between the helix and the antihelix is the *fossa of the helix*, or *fossa scaphoidea*. The antihelix curves round a deep, capacious cavity, the *concha*, which is partly divided by the commencement of the helix, the *crista helicis*. The meatus is at the bottom and anterior part of the concha. In front of the concha and projecting backward over the meatus is a small pointed eminence, the *tragus*. Opposite the tragus, and separated from it by a deep notch, the *incisura intertragica*, is a small tubercle, the *antitragus*. Below this is the *lobule*, which is not

FIG. 35.



THE LEFT PINNA (after Gruber).—*ch*, crista helicis; *h*, helix; *cf*, *cf'*, crura of the helix; *a*, antihelix; *fs*, fossa scaphoidea; *i*, fossa intercruralis; *c*, concha; *aG*, opening of external auditory canal; *t*, tragus; *at*, antitragus; *ii*, incisura intertragica; *l*, lobe.

firm like the rest of the auricle, owing to its having no cartilage, except in very rare cases, and being composed of compact areolar tissue and fat. (Fig. 36.)

The cartilage is deficient between the tragus and the beginning of the helix, the notch between them being filled with dense fibrous tissue. The

cartilage is what gives the pinna its form. It is yellow fibro-cartilage, in one piece, about two millimetres thick on the average. The crumpled form of the auricle is due to folds of the cartilage: these folds are held in place by fibrous bands. The cartilage is covered with skin continued from the side of the head. In adult males the skin on the incisura intertragica, as well as that on the surface of the tragus, is often covered with long coarse hairs. The integument is thin and adheres tightly to the cartilage, especially in front, where the subcutaneous tissue is dense and destitute of fat. The skin contains sebaceous glands, which are most abundant in the scaphoid fossa and the concha. At the front of the pinna, where the helix bends upward, there is a small projection of cartilage, called the *process of the helix*. The cartilage of the

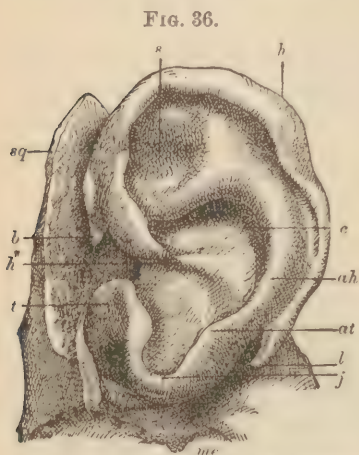


FIG. 36.
EXPOSED CARTILAGE OF THE AURICLE,
LEFT EAR (after Politzer).—*h*, helix; *h'*,
crista helices; *ah*, antihelix; *s*, fossa navi-
cularis; *t*, tragus; *at*, antitragus; *j*, in-
cisura intertragica; *l*, spina helices; *b*,
processus caudatus of the helix; *me*, car-
tilaginous meatus; *sq*, squamous portion.

pinna presents several fissures, which partially separate it into different sections. The *fissure of the helix* is a short vertical slit in the anterior part of the pinna, immediately behind the process of the helix, opposite the first curve. There is another fissure on the surface of the tragus. The antihelix is divided below by a deep fissure: one part terminates by a pointed extremity, the *processus caudatus*; the other is continuous with the antitragus.

The *ligaments* of the pinna are those connecting it to the head and those connecting the various parts of the pinna together. The extrinsic ligaments are two in number, anterior and posterior. The *anterior ligament* extends from the process of the helix to the root of the zygoma. The *posterior ligament* goes from the posterior surface of the concha to the outer surface of the mastoid process. A few fibres connect the tragus to the root of the zygoma. Two ligaments connect the parts of the pinna. One is a strong band stretching from the tragus to the commencement of the helix, completing the meatus and partly encircling the boundary of the concha; the other extends between the concha and the processus caudatus.

Fasciæ of the Ear.—The attachment of the auricle and cartilaginous meatus to the deeper parts is accomplished by bands of fascia, as well as by the skin and muscles. Anteriorly, both the superficial and deep fasciæ

give off bands which are attached to the outer surface of the cartilage of the auricle and blend with it: (1) a thin band from the superficial fascia to the anterior superior border of the pinna, extending to the posterior edge of the fossa of the helix; (2) a strong band from the deep temporal fascia to the spine of the helix; (3) a stronger band from the deep fascia to the tragus, superficially blending with the cartilage, and a deeper portion extending along the cartilaginous canal to its attachment to the osseous. A continuation of the temporal fascia goes still further into the osseous meatus along its upper and anterior wall. Posteriorly a band from the deep fascia is attached to the convexity of the concha just above the insertion of the *retrahens aurem*; another band from near the anterior border of the mastoid is inserted a little under the first. The auricle as a whole is attached rather loosely to the side of the head, especially behind.

The *deep cranial aponeurosis* gives support to the auricular muscles, and sends fibres to the auricle which are attached to the convexity of the concha along with the extrinsic ligaments.

The *superficial temporal fascia* sends fibres to the anterior surface of the tragus and to the spine of the helix. The deep fascia blending with these fibres in front of the tragus forms a strong band which is attached along the outer surface of the cartilage of the canal to its insertion, the band lying on the smooth shallow groove on the squamous bone between the auditory and tympanic plates.

The *muscles of the pinna*, like the ligaments, are in two sets: (1) those connected with the sides of the head,—viz., *attollens*, *attrahens*, and *retrahens aurem*; (2) those connected to the pinna only,—viz., *helicis major* and *minor*, *tragicus*, *antitragicus*, *transversus auriculæ*, and *obliquus auris*. These muscles are subcutaneous and in man rudimentary, in whom the auricle is but very slightly movable.

(1) The *attollens aurem*, the largest of the three, is thin and fan-shaped. Its fibres arise from the aponeurosis of the occipito-frontalis, and converge to be inserted by a thin flattened tendon into the upper part of the cranial surface of the pinna. It draws the auricle upward. The *attrahens aurem*, a thin, fan-shaped muscle, is the smallest of the three. Its fibres arise from the lateral edge of the epicranial aponeurosis, and are inserted together into the projection on the front of the helix,—the *spina helicis*. It draws the auricle a little forward and upward. The *retrahens aurem* consists of two or three fleshy fasciculæ, which arise from the mastoid region by short aponeurotic fibres. They are inserted into the lower part of the cranial surface of the concha. This muscle depends for its support on the occipital part of the occipito-frontalis, and in order to give the fibres of the *retrahens* stronger action the occipitalis is strongly contracted and held so during the movement of the *retrahens*. It draws the ear a little backward, stretching open the external meatus slightly. A small fasciculus has been noted going from the sterno-cleido-mastoideus to be inserted by a tendon at the region of the *eminentia conchæ*. It pulls the pinna downward and backward. The

action of these three muscles is in most persons involuntary, or exerted only when the whole scalp is moved.

The *nerves of the extrinsic muscles of the auricles*. The *attollens* is supplied by the *occipitalis major*; the *attrahens* by the *facial*; and the *retrahens* by the *posterior auricular branch of the facial*.

(2) The *helicis major*, a muscle usually present, is a narrow vertical band of muscular fibres situated upon the anterior edge of the helix. It arises below from the process of the helix, and is inserted into the anterior border of the helix just where it is about to curve backward.

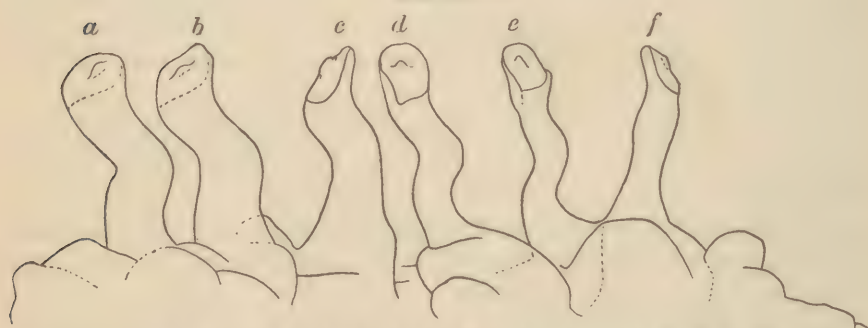
The *helicis minor* is an oblique fasciculus attached to the *crista helicis* and the bottom of the concha.

The *tragicus* is a short flattened band of muscular fibres, running vertically, situated upon the outer surface of the tragus.

The *antitragicus* arises from the outer part of the antitragus: its fibres are inserted into the *processus caudatus* of the helix. This muscle is one of the more distinct.

The *transversus auriculæ* is on the cranial surface of the pinna; it con-

FIG. 37.



OUTLINES FROM A PLASTER CAST¹ OF THE LEFT EXTERNAL AUDITORY MEATUS, VIEWED AT DIFFERENT ANGLES TO THE HORIZON IN THE ANTERO-POSTERIOR VERTICAL PLANE PASSING THROUGH THE CENTRE OF THE MEATUS.—*a*, from behind and above at about fifty-five degrees to the horizon; *b*, from behind and above at about thirty-five degrees to the horizon; *c*, from behind, *d*, from above, and *e*, from above and in front, at about forty degrees to the horizon; *f*, from above and behind at about thirty-five degrees to the horizon.

sists of radiating fibres, partly tendinous, and extends from the convexity of the concha to the prominence corresponding with the groove of the helix.

The *obliquus auris* consists of a few fibres extending from the upper and back part of the concha to the convexity immediately above it, called the *eminentia navicularis*. These small muscles exhibit considerable variety both as to their magnitude and their course, and frequently become atrophied in later life. Their action is to bend the pinna slightly.

The *external auditory canal* (Figs. 37 and 38) extends from the bottom of the concha to the *membrana tympani*, and consists of a cartilaginous and

¹ In the Warren Museum, taken by Dr. R. M. Hodges.

an osseous portion (Figs. 39 and 40). The general course of the meatus is inward, somewhat forward, and a very little upward, and as a whole it is somewhat flattened antero-posteriorly, with a sharp superior and inferior border. This elliptical form is less marked at the extremities of the meatus. The external limit of the meatus is here considered to be a plane at right angles to the longitudinal axis near the end of the tragus. The meatus has three quite abrupt angles. One angle is found in each of the two portions, the osseous and the cartilaginous, and the third angle where these two parts meet. The cartilaginous meatus is somewhat funnel-shaped, with the apex inward, and has no line of separation from the concavity of the concha. The outer two-thirds of the cartilaginous canal is straight and is directed inward and slightly forward. But the inner one-third of the cartilaginous portion goes inward and slightly backward, making an apparent angle as viewed from above of about one hundred and twenty degrees with the outer part. From the end of the cartilaginous portion the first part of the osseous canal extends inward, forward, and upward, making with the cartilaginous portion an apparent angle as viewed from above of about one

FIG. 38.



OUTLINES OF A CAST OF THE EXTERNAL AUDITORY MEATUS, TAKEN IN THE SAME WAY AS FIG. 37, BUT OF A RIGHT EAR AND SHOWING DIFFERENT CURVES.—*a*, from below and behind at about sixty degrees to the horizon; *b*, from below and behind at about forty-five degrees to the horizon; *c*, from below and behind at about twenty degrees to the horizon; *d*, from behind, *e*, from above, and *f*, from below and behind, at seventy-five degrees to the horizon.

hundred and fifteen degrees, thus lying in a plane nearly parallel to the vertical plane of the first part of the cartilaginous portion. As viewed from the side it forms an apparent angle of about one hundred and thirty-five degrees.

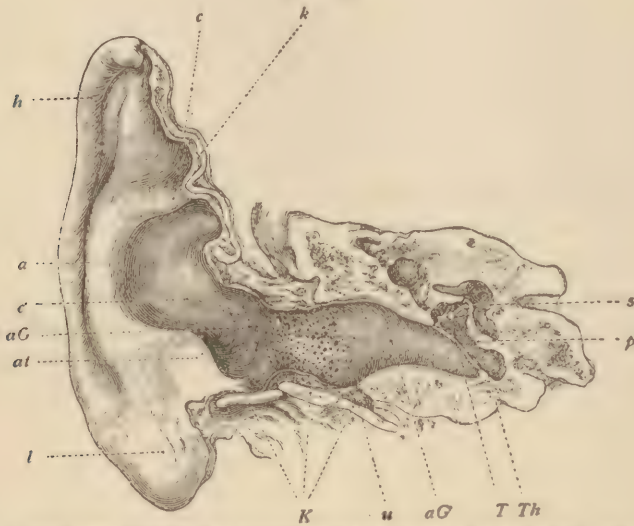
The inner portion of the osseous meatus is comparatively short, as its length is determined by the obliquity of the membrana tympani. It is formed almost entirely by the inferior anterior wall of the meatus. This part of the osseous meatus is directed inward, forming as seen from above an apparent angle of about one hundred and forty degrees with the outer part of the osseous portion, and as seen from the side an apparent angle of about one hundred and thirty-five degrees.

Owing to the flattening of the meatus, its section is elliptical, with its long axis directed downward and backward at an angle with the horizontal

of between forty-five and seventy-five degrees. The angles in the meatus may be referred to two planes at right angles to each other, one parallel to the long diameter of the meatus and the other parallel to the short diameter.

The bend of the cartilaginous meatus is between the pars externa and

FIG. 39.



VERTICAL SECTION OF THE RIGHT AUDITORY APPARATUS PARALLEL TO THE LONG AXIS OF THE MEATUS EXTERNUS, POSTERIOR SURFACE OF CUT (after Gruber).—*h*, helix; *a*, antihelix; *c*, *c'*, concha; *k*, cartilage of the pinna; *aG*, *aG'*, external auditory canal; *al*, antitragus; *l*, lobule; *K*, cartilage of the external auditory canal, with the fissures of Santorini; *u*, subcutaneous cellular tissue, with integument of the auditory canal; *T*, membrana tympani; *Th*, tympanic cavity; *p*, promontory; *s*, stapes, and nearer *s*, the section of the internal auditory canal.

the pars interna of the cartilaginous portion. The pars externa is about seven millimetres long, from the external orifice to where the meatus bends backward in a plane parallel to the short diameter of the meatus at an angle of about one hundred and thirty-five degrees. The pars interna of the cartilaginous meatus is about five millimetres long. At the junction of this part with the pars externa of the osseous meatus there is a bend in the canal forward in a plane parallel to the short diameters at an angle of about one hundred and twenty degrees, and upward in a plane parallel to the long diameters of the meatus at an angle of about one hundred and thirty degrees. The pars externa of the osseous meatus is about eleven millimetres long, and where it meets the pars interna the canal bends downward in a plane parallel to the long diameters of the meatus at an angle of about one hundred and thirty-five degrees, and backward in a plane parallel to the short diameters at an angle of about one hundred and forty-three degrees.

The external meatus auditorius taken as a whole has its external orifice parallel to the mesial plane of the skull, and its internal at an angle to this plane on account of the oblique position of the membrana tympani, which looks outward, forward, and downward, making the anterior wall of the

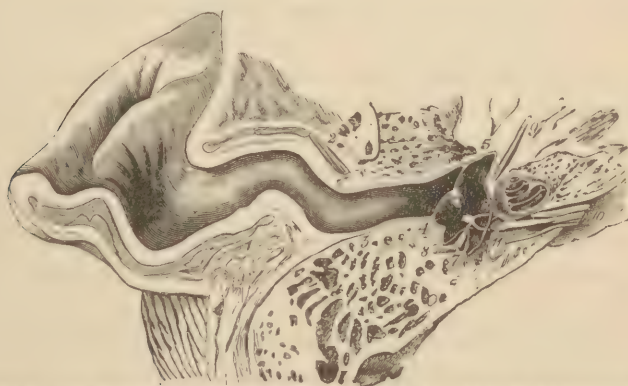
canal the longest. The following measurements of von Trötsch were found by taking for the most external boundary of the tube a plane projecting from the external end of the posterior wall at right angles to the longitudinal axis of the canal. From this plane each of the four walls was measured to the membrana tympani. Average length of the canal, twenty-four millimetres, giving sixteen millimetres to the osseous and eight millimetres to the cartilaginous parts. Anterior wall, twenty-seven millimetres,—cartilaginous nine millimetres, osseous eighteen millimetres; inferior, twenty-six millimetres,—cartilaginous ten millimetres, osseous sixteen millimetres; posterior, twenty-two millimetres,—cartilaginous seven millimetres, osseous fifteen millimetres; superior, twenty-one millimetres,—cartilaginous seven millimetres, osseous fourteen millimetres.

With the same method of measurement Symington gives this table showing the length of the meatus in children :

Age.	Length of floor.	Length of roof.
Two months	17 millimetres	13 millimetres.
Six months	19 "	14 "
Twelve months	20 "	15 "
Two years	22 "	16 "
Five years	23 "	16 "
Six years	24 "	17 "

The following measurements were made on casts, taking the base or outer boundary of the meatus on a line from the end of the tragus to the beginning of the elevation of the end of the crista helices. Extreme length

FIG. 40.



VIEW OF THE LOWER HALF OF THE AURICLE AND MEATUS IN THE LEFT EAR DIVIDED BY A NEARLY HORIZONTAL SECTION (Quain, after Rüdinger).—1, posterior wall, 2, anterior wall, of the cartilaginous meatus; 3, posterior wall of the osseous meatus; 4, 5, membrana tympani, with the handle of the malleus cut; 6, stapes; and to the right a section of the cochlea; 7, stapedius muscle; 8, section of facial nerve; 9, part of the tensor tympani muscle; 10, branches of the auditory nerve; 11, utricle.

in a straight line, thirty-eight to forty millimetres; measured on anterior surface, forty and one-quarter to forty-one and one-quarter millimetres; first part of the cartilaginous meatus, fourteen and a half to sixteen and one-quarter millimetres; second part, six to nine millimetres, and osseous

part, eighteen to nineteen and three-quarters millimetres ; length of the axis of the meatus, forty-three to forty-four and three-quarters millimetres.

The capacity of the external auditory meatus is subject to many lateral and individual variations, ranging from the size of a goose-quill to that of the little finger. The lumen of the external meatus tapers gradually inward almost to the membrana tympani, where it enlarges again a little. The part having the smallest lumen is called the *isthmus*. There are also other irregularities of the lumen, which are occasionally well marked : for instance, the lumen of the cartilaginous meatus gradually becomes wider just inside the external orifice and narrows again as it approaches the osseous portion. The isthmus is distant from the membrana on the anterior wall seven to eight millimetres ; on the posterior wall one to two millimetres. The transverse diameter of the canal at the isthmus is six millimetres, and at the inner and outer ends of the osseous canal nine to ten millimetres, usually slightly less at the inner end. In some individuals, and usually in the aged, the posterior edge of the angle between the outer and inner cartilaginous parts infringes upon the lumen of the canal, nearly closing it.

The cartilage of the pinna is continued inward to form the cartilaginous part of the external canal. It does not form a complete tube, however, as it is deficient at the posterior and upper part. The cartilage gradually tapers from a complete tube down to a strip ending in a point at the anterior and lower part of the canal where it joins the bone. The gap is filled by fibrous tissue continuous with that which fastens the cartilaginous canal to the bone. The fibrous portion of the cartilaginous meatus passes without interruption into the lining membrane of the superior wall of the osseous meatus. The attachment to the inferior and lateral margins of the osseous canal—*i.e.*, to the tympanic bone—is formed by a compact mass of connective tissue containing elastic fibres. This allows a considerable abduction of the cartilage from the bony canal. The mobility of the cartilaginous canal is much increased by the *fissures of Santorini*. Motion is most extended upward and backward.

The capsule of the articulation of the lower jaw is in close connection with the cartilaginous meatus on its lower and anterior aspect. This allows the movements of the condyle of the jaw to move the meatus to a considerable degree.

The continuity of the cartilage is interrupted by several fissures (Figs. 39 and 40) which run nearly parallel to the outer end of the osseous canal and are bridged by fibrous tissue. These are the *fissures of Santorini*. There are two or three of these fissures, and they are usually placed on the antero-inferior aspect of the canal, occasionally extending to the posterior wall. Sometimes they are forked. On the inside the cartilaginous canal is covered with perichondrium, and the osseous canal with periosteum. The integument lining the canal is bound to the periosteum and the perichondrium by firm subcutaneous tissue which becomes denser farther in. This integumentary lining is continuous with the outer layer of the membrana

tympani and the covering of the pinna. In the cartilaginous canal it resembles ordinary skin, while in the osseous part it is thinner, becoming very thin as it approaches the membrana tympani, and having the color of mucous membrane, but resembles it in no other respect. The skin along the upper posterior wall of the osseous meatus is considerably thicker than elsewhere, and here contains blood-vessels, supplying the membrana tympani.

The epithelium of the canal is stratified, and the skin contains hair-follicles with their sebaceous glands, and also ceruminous glands. The papillæ are peculiar in that they are annular in form, encircling the canal, and are parallel to the membrana tympani. The hairs are found on the cartilaginous portion, and occasionally encroach on the osseous. The ceruminous glands begin about two millimetres from the orifice of the canal and stop at the osseous meatus, except for a triangular area extending farther in on the upper and posterior wall. They are most numerous at the junction of the cartilaginous and osseous canals, where there may be ten or more to the square millimetre.

The glands on the upper wall are usually the larger. They are tubular, and resemble sweat-glands in structure. Their excretory ducts, according to Gruber, have a diameter of five-hundredths to six-hundredths of a millimetre, and the glands measure from one-fifth to four-fifths of a millimetre. These glands secrete the cerumen. This is bright yellow, and is nearly fluid when fresh, becoming darker and thicker on exposure to the air.

The muscles of the cartilaginous canal are said to be two. One, described as a band passing over the fissures of Santorini on the anterior surface of the canal, is called *musculus incisurarum Santorini*. The other, of rare occurrence, is the *stylo-auricularis*. It arises from the upper part of the styloid process, and is inserted by a fan-shaped tendon close to the inner part of the cartilage. The platysma myoides muscle is said to send fibres occasionally to the under surface of the cartilage.

Blood-Supply of the Auricle and External Meatus.—The posterior auricular artery, a branch of the external carotid, supplies the posterior surface of the auricle and outer part of the canal, through its rami auriculares posteriores; and by its rami perforantes it supplies the anterior surface, anastomosing with the arteriæ auriculares anteriores. The superior anterior auricular and two or three inferior anterior auricular arteries, branches of the superficial temporal, all supply the lobe, the tragus, and the anterior wall of the cartilaginous meatus, and also the upper part of the helix. The auricular branch of the occipital supplies the back of the concha. The arteria auricularis profunda of the internal maxillary supplies the inner part of the meatus, and sends branches to supply the membrana tympani, running along the superior posterior ridge of the meatus, and along the handle of the malleus to its tip.

The veins of the auricle and external meatus are provided with valves, and are very irregular in their connections.

The veins of the back of the ear communicate through the vena emis-

saria mastoidea in the foramen mastoideum with the sigmoid sinus, or unite as *venæ posteriores* with the external jugular.

The anterior veins of the ear empty into the *vena temporalis superficialis* or the *vena facialis posterior*.

The veins of the deep part of the external ear empty into the pterygoid plexus, or into the *vena facialis posterior*.

The *lymph-vessels* of the external portion of the ear communicate with the subauricular glands in the neighborhood of the mastoid process and with the superficial facial glands in the neighborhood of the parotid gland. The superficial cervical glands lying between the platysma and the sternocleidomastoid also receive lymphatics from the ear.

The *nerves* of the external portion of the ear come from the cervical plexus, facial, vagus, and trigeminal nerves. The sensory supply is by the superficial cervical plexus, except for the concha and rising anterior part of the helix, which is supplied by the inferior maxillary nerve.

The auricularis magnus from the anterior branch of the third cervical accompanies the posterior auricular artery and supplies the mastoid process, the upper part of the auricle, the posterior surface of the lobe, and by its perforating branches the lower half of the anterior surface of the auricle and external meatus. It communicates with the auricular branch of the facial nerve and with the vagus.

The auriculo-temporal from the inferior maxillary, the third division of the trigeminus, divides into the *nervi meatus auditorii externi* inferior and superior, going to the auditory canal. The inferior branch supplies the integument of the cartilaginous canal. The superior branch, ascending behind the head of the inferior maxilla, divides. The external branches go to the helix, concha, and upper wall of the auditory canal, and the internal branches perforate the canal and go to the membrane.

The occipitalis minor sends a small branch, the *nervus auricularis superior*, to the pinna and communicates with the auricularis magnus. The auricular branch of the vagus, or Arnold's nerve, supplies the posterior surface of the auricle, the lower part of the anterior surface, and the cartilaginous part of the external auditory canal, and communicates with the auricularis magnus. The facial nerve sends the *rami auriculares posteriores externi* and the *ramus auricularis internus* to supply the muscles of the pinna.

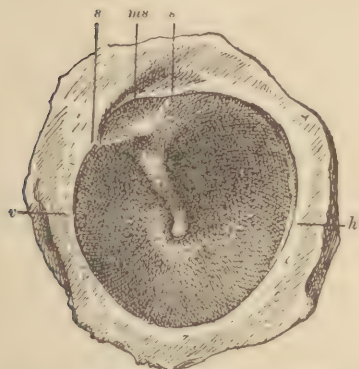
THE MIDDLE EAR.

The middle ear includes the drum-membrane, the tympanic cavity and its contents, the mastoid cells, and the Eustachian tube. The cavity is not so large as in the macerated bone, owing to the occlusion of many of the bony cells by folds of mucous membrane, especially in the mastoid region.

The *membrana tympani* (Figs. 41 and 42) is situated at the inner extremity of the osseous meatus, and is placed obliquely to the long axis of the meatus, the plane of the membrane forming an obtuse angle with the superior wall of the meatus and an acute angle with the inferior. The

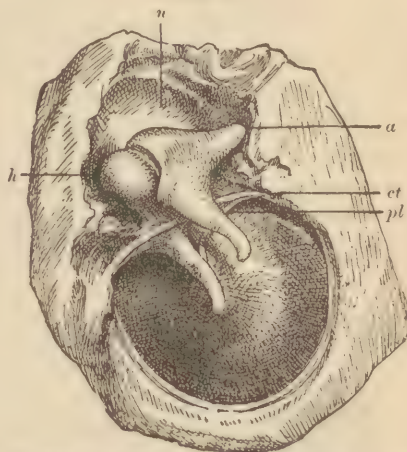
margin of the membrane is attached in the sulcus tympanicus of the tympanic ring. In front and above in the neighborhood of the incisura Rivini, however, the sulcus is wanting, and the membrane is partly attached to the grooveless margo tympanicus and partly to the lining membrane of the osseous meatus.

FIG. 41.



OUTER SURFACE OF THE LEFT TYMPANIC MEMBRANE OF AN ADULT, enlarged three and one-half times (after Politzer).—*v*, anterior segment of the membrana tympani; *h*, posterior segment of the membrana; *s, s'*, Prussak's bands passing from the short process of the malleus to the spina tympani major in front and posterior behind; *ms*, membrana Shrapnelli. The posterior fold of the membrana tympani is slightly marked, lying below and nearly parallel with Prussak's posterior band.

FIG. 42.



INNER SURFACE OF THE RIGHT MEMBRANA TYMPANI, WITH THE MALLEUS AND INCUS ATTACHED, enlarged three and one-half times (after Politzer).—*n*, niche of the outer wall of the tympanic cavity; *h*, head of the malleus; *a*, short process of the incus; *pl*, fold of the posterior pouch of the membrana tympani; *ct*, chorda tympani nerve. The fold of the anterior pouch of the membrana lies in front of the neck of the malleus, concealing the upper anterior attachment of the membrane and carrying the chorda tympani nerve to the anterior osseous wall.

The form of the membrane corresponds to the shape of the inner end of the meatus, and its chief varieties are formed by changes in the sides of the ring, whether straighter or more sharply curved, and also by changes in the size of the incisura Rivini and the bay of the posterior wall, which may make the ring cordate or ovoid. The membrane is bulged out towards the periphery in two places, one behind and above in the bay of its posterior wall, the other at the incisura Rivini, at the anterior superior pole of the membrane. This segment is marked off from the remaining periphery of the membrana by two more or less sharply defined angles, the distance between which (according to Politzer) is two and one-half to three millimetres, and the height of the rounded segment between them is about two millimetres.

The size of the membrana tympani depends upon the size of the inner end of the meatus. The greatest longitudinal diameter from the spina tympanica major to the lowest point of the inferior margin (according to Politzer) is nine and one-half to ten millimetres; the greatest transverse diameter from the anterior to the posterior margin is eight and one-half to nine millimetres. The thickness of the membrane (according to Henle) is one-tenth of a millimetre. The inclination of the membrane depends on

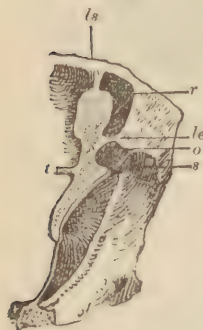
the inclination of the *suleus tympanicus*. The *membrana tympani* looks outward, downward, and forward. It is tipped downward at an angle of about forty-five degrees, and is turned forward about ten degrees. This position places the inferior anterior border of the membrane nearest the median line and farthest from the mouth of the meatus, and the posterior superior border farthest from the median line and nearest the external meatus. Hyrtl states that the angle of inclination of the plane of the membrane to the inferior wall of the meatus is fifty degrees, but that it is not constant. Huschke says the planes of the two *membrana tympani* prolonged inward and downward would intersect at an angle of one hundred and thirty degrees. Von Tröltzsch says the average angle formed by the membrane and the superior wall of the meatus is one hundred and forty degrees.

The *membrana tympani* (Fig. 43) is not stretched out flat, but forms an outwardly convex fold. The ridge of this fold has the shape of a horse-shoe, the ends almost meeting as it follows round the *annulus tympanicus* midway between the manubrium and the ring, beginning on the anterior side of the manubrium and going downward round the tip of the handle and up to the posterior side of the handle, thus forming the outwardly umbilicated surface of the membrane, the umbilicus corresponding to the end of the manubrium. This point is called the *umbo*, and its position whether farther in or farther out than the plane of the ring depends on the position of the manubrium: the usual position is probably a little farther in. The curve of the *membrana tympani* flattens out somewhat in the posterior segment, and is altogether wanting in the membrane of Shrapnell. The curve is caused probably by the tension of the circular fibres, and its umbilication by the inward traction of the manubrium of the malleus, the outward tendency of the curve, which is especially well shown at the periphery of the membrane, being due in part to the greater tension of the inner layer of radiating fibres over the outer layer.

The handle of the malleus is intimately united with the layers of the *membrana*, and extends in an oblique direction from in front and above, downward and backward, along a shallow groove opening outward and ending at the *umbo*. The handle divides the membrane into two unequal parts, a lesser anterior and a greater posterior, and extends downward from the short process. The anterior superior end of the short process makes a strongly-marked projection on the membrane.

From the tip of the short process two folds (Figs. 41 and 44) or ridges of the membrane cross the *membrana tympani*, one going forward and one

FIG. 43.



LONGITUDINAL SECTION OF THE MALLEUS, ALSO SECTION OF PRUSSAK'S CHAMBER, MEMBRANA TYMPANI, AND UPPER AND OUTER TYMPANIC WALLS: DECALCIFIED BONE (after Politzer).—*ls*, suspensory ligament of the malleus; *le*, external ligament of the malleus; *s*, Shrapnell's membrane; *o*, Prussak's chamber; *r*, space external to the malleus and incus bounded by the niche; *t*, tendon of the tensor tympani muscle. The section of the tympanic membrane shows the outward curve of the periphery, which bends in again towards the *umbo* at the tip of the malleus.

backward. They come to the periphery a short distance below the Rivinian segment. These folds are due to the change in tension between that part of the membrane below them and that above, the membrane below being much more tightly stretched and curved and that above quite loose and flat. The posterior fold is the more distinct, from the fact that the fold in extreme outward excursion of the malleus is chiefly formed by the bulging of the membrana caused by the pushing outward of the short process of the incus, and in extreme inward excursion by the tense fibrodermoid band coming down from the upper posterior wall to the upper part of the posterior border of the malleus. Above these folds there are two short tightly-stretched striæ, called *Prussak's fibres* (Fig. 44, *be* and *ec*), going from the tip of the short process to the corners of the notch of Rivinus. The posterior fibre is attached to the spina tympani posterior above the posterior ligament of the malleus, and the anterior fibre to the spina tympani major. These are Prussak's fibres. That part of the membrane bounded by Prussak's fibres and the incisura Rivini is called the *membrana flaccida Shrapnelli* (Fig. 41, *ms*). It is much thinner and less tense than the other parts of the membrana tympani: it forms the outer wall of a small space lying above the short process, called *Prussak's space*.

Shrapnell's membrane consists of loose fibres of connective tissue which cross one another irregularly and are covered internally with mucous membrane and externally with a thin layer of cuticle. In this region the blood-vessels of the meatus and tympanum anastomose to a slight extent.

The connection between the handle of the malleus and the membrana tympani is accomplished by a cartilaginous sheath (Fig. 45, *a*) which fits over the external surface of the handle from the short process to the umbo. It projects about one-half millimetre below the umbo, and is thickest upon the short process. The upper portion is not so closely adherent to the malleus as the lower, its attachment admitting a certain amount of motion. The fibres of the membrana propria are attached to this cartilage.

The membrana tympani consists of three layers (Fig. 46), a middle fibrous layer, the lamina propria, an external dermoid layer, and an internal mucous layer. The *mucous layer* is continuous with the mucous membrane of the tympanum, and is very intimately connected with the fibrous layer. It consists of non-ciliated pavement epithelium with a Malpighian mucous layer, but possesses only a very slight stratum of connective tissue, which differs in arrangement from the fibres of the fibrous layer of the membrana.

FIG. 44

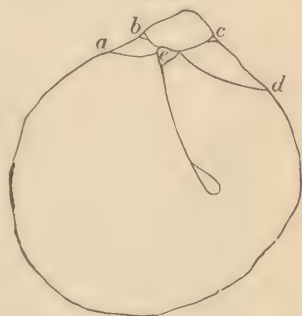


DIAGRAM OF THE TOPOGRAPHY OF THE OUTER SURFACE OF THE MEMBRANA TYMPANI (after Kessel).—*c*, short process of the malleus; *ac*, anterior fold of the membrana; *ed*, posterior fold of the membrana; *be*, anterior band of Prussak; *ec*, posterior band of Prussak; *bec* encloses Shrapnell's membrane.

The *dermoid layer* is continuous with the skin of the meatus. It is thickest close to the manubrium, behind which a strongly-developed cutaneous band extends from the superior wall of the meatus to the membrane, leaving a triangular space back of the handle with its apex towards the end of the handle. This cutaneous band contains connective-tissue and elastic fibres, besides vessels and nerves going from the meatus to the membrane. This band is called the descending fibres of Prussak. At the umbo the

FIG. 45.



SECTION THROUGH THE LONG AXIS OF THE MALLEUS AT RIGHT ANGLES TO THE MEMBRANA TYMPANI, FROM AN ADULT (Burnett, after Brunner).—*k*, section of the wall of the incisura Rivini; *g*, head of the malleus; *p*, neck of the malleus; *o*, handle of the malleus; *l*, short process of the malleus; *j*, membrana flaccida of Shrapnell; *h*, ligamentum mallei externum; *m*, chorda tympani nerve; *n*, tendon of the tensor tympani; *i*, Prussak's chamber; *a*, cartilaginous sheath of the outer surface of the malleus; *b*, radiating layer of fibres of the membrana propria of the membrana tympani; *c*, dermoid layer of the membrana tympani; *e*, Haversian canals; *f*, medullary space; *d*, circular layer of fibres of the membrana propria of the tympanic membrane.

FIG. 46.



SECTION THROUGH THE ANNULUS TENDINOSUS, EMBEDDED IN THE SULCUS TYMPANICUS, AND THROUGH THE PERIPHERAL PORTION OF THE TYMPANIC MEMBRANE (after Politzer).—*su*, sulcus tympanicus with the annulus tendinosus, the fibres of which merge in an upward direction into the *r*, layer of radiating fibres of the membrana tympani; *cu*, cutis of the lower wall of the external meatus continuous with the *cu*, cutis layer of the membrana tympani; *c*, section of the circular layer of fibres of the membrana tympani; *s*, mucous layer of the membrana tympani, and tympanum with its epithelial covering.

connective-tissue fibres of this bundle spread out towards the periphery, and some of them unite with the fibres of the lamina propria.

The *lamina propria* consists of two separate lamellæ, an external radiating layer connected with the dermal layer, and an internal circular layer connected with the mucous membrane. According to Helmholtz, these fibres are very similar to tendinous fibres both in appearance and in chemical reactions. The lamina propria is attached peripherally to the inner border

of the *annulus tendinosus* (Fig. 46), which is triangular on section and is fixed in the sulcus tympanicus; some of the fibres of the lamina go to the periosteum of the meatus and the mucous layer of the tympanum. In the lower segment the radiating fibres are attached together with the circular fibres to the end of the handle; but in the superior segment, where they are less numerous, they are attached to the edge of the manubrium. They become more dense towards the umbo, partly because they multiply and partly because they are aggregated in a smaller space. These fibres are wanting in Shrapnell's membrane. The inner or circular layer is formed of fibres which lie at right angles to the radiating fibres and have a circular direction. At the margin they are closely connected with the radiating fibres. Both layers are, however, easily separated through their whole extent. The circular fibres can be traced to the tendinous ring. They are most abundant midway between the handle and the periphery of the membrane. These fibres are wanting in Shrapnell's membrane. Both layers amalgamate and are attached to the manubrium, the radiating fibres mostly below and the circular above. They surround its inferior extremity, where the fibres are most closely connected with the manubrium. Above, the fibres are attached to the outer surface of the manubrium.

Between the fibres of the two layers there is a series of lymph-channels, formerly called von Tröltzsch's corpuseles, which are spindle-shaped on longitudinal section and stellate on transverse, and are lined with endothelium. The inner mucous layer is continuous with the lining of the tympanum, and consists of a very scanty stratum of connective tissue and non-ciliated pavement epithelium. Underneath the epithelium of the mucous layer a low power of the microscope will sometimes show a fibrous framework of peculiar structure lying upon the substantia propria and most developed behind the manubrium. From the membranous expansion of this framework, which is interrupted here and there by large and small interspaces, fibrous processes radiate towards the handle of the malleus as well as towards the peripheral tendinous ring, and some are united to the substantia propria.

There are said to be openings in the epithelial layer of the mucous membrane which communicate with the lymph-spaces of the membrana. Gerlach described projections from the inner surface of the membrana tympani, most numerous in infants. These projections are sometimes globular and sometimes elongated. The larger globular ones are visible to the naked eye. They are most numerous on the periphery of the membrana. Their centres consist of connective tissue and vascular loops, but have no nerves, and they are covered by a layer of pavement epithelium. They are called the *villi of the membrana tympani*.

The membrana has two chief arteries. The arteria tympanica interna from the ramus tympanicus of the stylo-mastoid artery of the external carotid is sometimes reinforced by small branches from the deep auricular artery, and it also communicates with the middle meningeal. It enters the

tympanum through the fissure of Glaser and supplies the mucous layer of the membrana. The arteria auricularis profunda, a branch from the internal maxillary, gives off the arteria tympanica externa, which supplies the cuticular layer of the membrana. There is said to be also a short direct branch from the internal carotid in the carotid canal to the membrana tympani. Each artery forms a vascular net-work in its own layer, while between the two there is the slightly vascular membrana propria. These two vascular net-works anastomose with each other only at the periphery of the membrana. The dermal layer has a larger blood-supply than the mucous layer. A comparatively large artery descends along the posterior border of the manubrium in the dermoid layer to the umbo and gives off many small radiating branches, especially near the umbo. These finally break up into a fine net-work which anastomoses with a series of small converging arteries from the periphery of the membrana. The vessels of the mucous layer are smaller and form a finer and more extensive net.

The *veins* of the membrana tympani are arranged very much in the same way as the arteries. They are more abundant along the handle of the malleus and the periphery of the membrana, and are connected with the veins of the meatus and the tympanic cavity.

The *lymphatic vessels* of the membrana (according to Kessel) are, like the blood-vessels, arranged in the three layers of the membrana, anastomosing with one another. Through the interspaces in the framework the blood-vessels and lymphatic vessels of the tympanic surface are connected with those of the external surface of the membrane. The lymphatics of the mucous membrane, entering through the interspaces of the mucous layer, join the system of cavities of the membrana. Kessel describes a system of lymphatic canals in the mucous layer extending over the whole surface, but most strongly developed along the handle and towards the peripheral tendinous ring.

The outer surface of the membrana tympani is supplied with *nerves* by the internal branch of the nervus meatus auditorii externi superior, a branch of the auricular temporal from the trigeminus, which perforates the auditory canal to reach the membrana tympani, two or three branches following the manubrium and spreading out on the membrana. Their terminations are unknown. The nerve-fibres of the cutis, while regularly dividing dichotomously, penetrate the lamina propria and come into connection with the nervous plexus of the lining membrane. Nerves are not abundant either in the mucous layer or in the membrana propria.

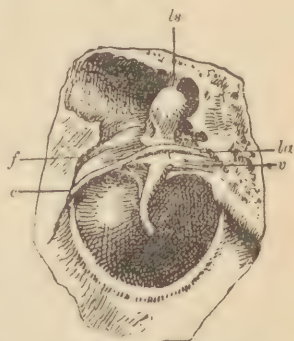
The inner aspect of the membrana tympani (Fig. 42) shows the handle of the malleus covered by the mucous layer of the membrana protruding inward as if it lay on the membrane. The head of the malleus and the greater part of the incus lie above the membrane. The chorda tympani nerve goes across the tympanum nearly at right angles to the handle of the malleus and parallel to the membrana, close to which it lies in its course, from its entrance by the posterior canal of the cord in the posterior wall

of the tympanum near the upper end of the tendinous ring of the membrana, to its exit into the fissure of Glaser. The nerve passes between the manubrium of the malleus and the long process of the incus. It is attached to the inner surface of the malleus about the centre of the flat rhomboidal surface at the base of the handle, and forms part of the fold of the posterior pocket. Anteriorly it follows the anterior ligament of the malleus and lies at the base of the fold of the anterior pocket of the membrana. The pockets of the membrana tympani (Fig. 47) are two pouches opening downward, lying on the inner side of the membrana, the membrana forming their external boundaries. Their inner boundaries or folds have free lower borders. The anterior one is in front of and the posterior one behind the malleus.

The *anterior pocket* is not exactly homologous to the posterior pocket, and is much smaller. Its form is that of a truncated pyramid, with its apex formed by a delicate membrane. This membrane connects the anterior band of Prussak's fibres with the anterior ligament of the malleus, and thus forms the anterior half of the floor of Prussak's chamber. It is occasionally perforated. The inner wall of the pocket is formed by the spina major tympani and the anterior ligament of the malleus; the posterior wall by the malleus; the anterior wall by the annulus tympanicus; and the outer wall by the membrana. The chorda tympani nerve does not, as a rule, form part of the fold of this pocket, as it usually passes above the fold along the anterior ligament of the malleus. The border of this pocket is formed by the anterior ligament of the malleus, and is usually free, but sometimes is connected with the mucous fold of the tensor tympani tendon. The *posterior pocket* is variable in size, depending on the size of its fold. The free border of the pocket varies in level from the base of the manubrium in very small pockets to half-way down the manubrium in very large ones. The fold of the pocket is a reduplication of mucous membrane enclosing the chorda tympani nerve and a strong band of ligamentous fibres, the *posterior ligament of the malleus*. The fold of the pocket lies nearly parallel to the membrana tympani, approaching it slightly above. The anterior third of the free border of the pocket is formed by the posterior ligament of the malleus, and the posterior two-thirds by the chorda tympani.

The posterior ligament of the malleus is attached anteriorly along the inner edge of the posterior aspect of the manubrium, about the level of the attachment of the tensor tympani or a little below it, and posteriorly close to the inner side of the annulus tympanicus, below Prussak's posterior

FIG. 47.



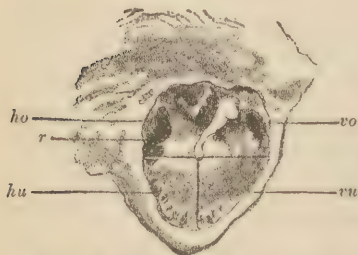
THE INNER SURFACE OF THE LEFT MEMBRANE IN SITU AFTER REMOVAL OF THE INCUS (after Politzer). —*m*, suspensory ligament of the malleus; *f*, fold of the posterior pouch of the membrana tympani; *v*, fold of the anterior pouch of the membrana tympani, and anterior ligament of the malleus; *la*, *c*, chorda tympani nerve.

fibre, at a spot about on a level with the anterior spine of the tympanum and close to the membrana. At this point there is the spina tympanica posterior, a small flat spine, projecting forward, for the insertion of the ligament. The ligament goes upward and backward from the malleus. The action of the posterior ligament of the malleus is to resist forward motion of the manubrium chiefly, and inward motion to a slight degree. The roof of the posterior pocket, like that of the anterior pocket, is a thin membrane, whose external border coincides with the anterior Prussak fibre and separates the pocket from Prussak's chamber. This membrane is often perforated. The fold of the posterior pocket is often adherent at its otherwise free border to the long process of the incus. The posterior pocket is bounded above by the floor of Prussak's space; anteriorly by the posterior surface of the manubrium; externally by the membrana tympani; posteriorly by the annulus tympanicus, just internal to the sulcus; and internally by the fold of the pocket.

Prussak's chamber is a small space lying between the neck of the malleus and the membrana flaccida of Shrapnell. Its roof is formed by the external ligament of the malleus, and its floor by the thin membranes covering the bottom of the pockets of the membrana tympani. These membranes slope downward towards the upper surface of the short process of the malleus. The space thus enclosed usually communicates with the rest of the tympanic space, under the posterior border of the external ligament of the malleus. Not infrequently Prussak's chamber opens into the posterior pocket of the membrana, and it more rarely opens in other directions.

Topographical Relations of the Membrana Tympani to the Inner Wall of the Tympanic Cavity. (Fig. 48.)—The part

FIG. 48.



VIEW IN PROJECTION OF THE INNER TYMPANIC WALL, SHOWING ITS RELATION TO THE MEMBRANA TYMPANI: RIGHT EAR, ENLARGED (after Politzer).—*vo*, anterior superior quadrant of the membrana; *vu*, anterior inferior quadrant of the membrana; *ho*, posterior superior quadrant of the membrana; *hu*, posterior inferior quadrant of the membrana; *r*, niche of the fenestra rotunda.

of the membrana tympani nearest to the inner wall of the tympanum is the umbilical depression, which corresponds with the inferior extremity of the handle of the malleus. From the umbo to the promontory is two millimetres (Poltzer) on an average; one to one and one-half millimetres below this is the most prominent part of the promontory, and from here to the membrana is two and one-half millimetres (Poltzer) or more. From the posterior part of the membrana to the inferior wall is from two and one-half to four millimetres (Schwartz). The posterior superior quadrant of the membrana lies external to the stapes; the membrana is two and one-half to three milli-

metres (Poltzer) from the head of the stapes, and one and one-half to two millimetres (Poltzer) from the long process of the incus. These bones can

rarely be seen, except through the most transparent membranes; and then all that appears of them is the tip of the long process of the incus, and the tendon of the stapedius muscle. Oftentimes they are wholly above and behind the membrana.

The delicate mucous lining of the tympanic cavity is a continuation of the pharyngeal mucous membrane through the Eustachian tube. It covers not only the walls of the tympanum and the inner surface of the membrana tympani, but also all the structures contained in the cavity. It is closely connected by its fibrous layer to the periosteum, and consequently allows little or no motion over the bone. It forms as a whole a delicate membrane covered by epithelium which secretes a mucous fluid. In the new-born this mucous tissue is thicker and more vascular and is covered with papillæ. Mucous glands are found in considerable numbers only in the anterior portion of the tympanum. In the middle and posterior parts they are very rare. Wendt has demonstrated their presence on the promontory. As the mucous membrane covers the various structures in the tympanum, it often forms duplicatures or folds in passing from one to the other. The epithelium of this mucous membrane is pavement on the promontory, and on the other walls it is columnar and ciliated (Kölliker), containing tapering basal cells (Brunner) and goblet cells (Kessel). In parts of the tympanum the superficial connective-tissue system has been found to resemble the trabeculated structure of the inner surface of the membrana tympani. Politzer describes certain connective-tissue filaments of peculiar structure which are found in the tympanic cavity, especially in the antrum mastoideum. These are usually oval and often a little constricted and pear-shaped. They measure from one-tenth to nine-tenths of a millimetre (Politzer). These small bodies are covered with epithelium, and have a fibrous structure which is stratified. Each is traversed longitudinally by a fibrous stalk of varying size, which is attached at its ends either to the bone or to the mucous membrane, one stalk sometimes carrying more than one body. Their function has not been ascertained.

The walls of the mastoid cells are covered with a thin mucous membrane, continued from the tympanic cavity. It is closely united to the periosteum, and has a non-ciliated layer of epithelium. Here the mucous membrane also often forms folds in passing from one osseous lamella to another, these folds serving to limit the cell-spaces and forming a series of supplementary cells. The mucous membrane frequently stretches across the mouths of the osseous cells, completely separating the air-chambers. In the antrum there can be seen not infrequently a radiating system of mucous fibres and bands with a longitudinal axis. In the rare cases where there is perforation in the wall of the sigmoid sulcus, the lining membrane of the mastoid cells and the venous wall come into immediate contact.

Articulation of the Ossicula.—The articular surfaces on the head of the malleus and the crown of the incus are covered with articular hyaline cartilage, and are enclosed by synovial membrane. The cavity of the joint

is divided by an inter-articular fibro-cartilage, which is thickest internally. The capsule of the joint is thickest externally. The joint does not allow extensive motion. What motion there is is an inward and outward rotation of the malleus on an axis passing through the head of the malleus and the short process of the incus. The inward motion is checked by the interlocking cogs of the bones, while the outward motion is comparatively extensive. When this motion takes place the capsule of the joint is relaxed, allowing a slight separation of the articular surfaces. During the last part of the inward motion and the first part of the outward motion of the manubrium of the malleus there is very little if any motion in the malleo-incudal joint, the long process of the incus moving in and out with the manubrium. Under these conditions the excursion of the tip of the long process of the incus is two-thirds that of the manubrium, and consequently the pressure exerted by the incus on the stapes is one and one-half times greater than the pressure exerted on the manubrium (Helmholtz).

The *incudo-stapedial articulation* is formed by the convex surface of the lenticular process of the incus and the cup-shaped head of the stapes. Both are covered with cartilage. On the head of the stapes the area of the cartilage is greater than that of the bone. The synovial joint is encased by a fibrous capsule somewhat stronger on the lower side. The joint admits of very little separation of the bones, but allows motion in all directions to a limited extent.

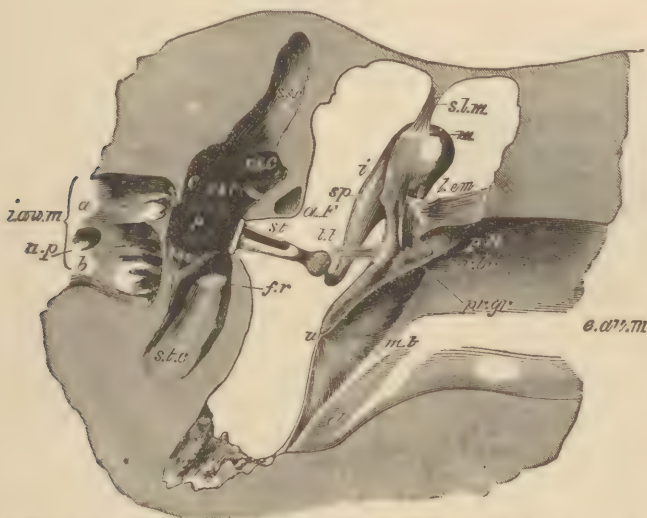
The articulation of the foot-plate of the stapes with the fenestra ovalis is accomplished by a thin annular ligament called the *obturator or annular ligament of the stapes*. It appears as a continuation of the periosteum. The vestibular surface and margin of the stapes is covered by hyaline cartilage. The obturator ligament is thicker at the posterior and inferior margin. This is perhaps what allows the foot-plate to make greater excursions with its anterior superior border. By using the posterior inferior margin as a fulcrum, the head is displaced backward and downward.

The articulation of the tip of the short process of the incus and the posterior wall of the tympanum is an amphiarthrosis, as there is a thin layer of cartilage on the tip of the short process of the incus and on the corresponding sella incudis of the tympanic wall. The posterior ligament of the incus serves to strengthen this articulation. It is composed of an outer and an inner more or less fan-shaped band of glistening tendinous fibres, which arise from the sides of the sella incudis and are attached to the sides of the tip of the short process. The insertion of the outer band is at the top of the outer surface of the short process. It is directed obliquely downward at an angle of forty-five degrees. The inner band of the ligament is often very short. It is nearly horizontal, and is inserted into the bottom of the inner surface of the short process of the incus.

The ossicles are joined together in a chain, of which the outer extremity is formed by the handle of the malleus and the inner by the foot-plate of the stapes. The long process of the incus has a direction almost parallel

to the manubrium of the malleus, while the incus is joined to the stapes nearly at right angles. When the ossicular chain is in position (Fig. 49) the handle of the malleus extends along the membrana tympani, and the foot-plate of the stapes is turned inward and lodged in the fenestra ovalis. The articulated larger extremities of the malleus and incus are situated above the membrana tympani, under the outer part of the vaulted roof of the tympanum, the *recessus tympanicus* or *niche*. The ossicular chain is so balanced, according to Blake, that its axis of motion divides the chain into an upper and a lower part, the ratio of the upper to the lower being 18 : 7. This counterbalance prevents pendular vibrations of the ossicles. The short

FIG. 49.



PROFILE VIEW OF THE LEFT TYMPANUM FROM BEFORE AND SOMEWHAT FROM ABOVE, THE ANTERIOR PART HAVING BEEN CUT AWAY, magnified four times (after Quain).—*m*, head of the malleus; *sp*, lower anterior part of the prominent border of the articular surface; *pr.br*, the short process of the malleus; *pr.gr*, root of the processus gracilis, cut; *s.l.m*, suspensory ligament of the malleus; *t.e.m*, external ligament of the malleus; *u*, tendon of the tensor tympani muscle, cut; *i*, incus, and below, its long process; *st*, stapes in the fenestra ovalis; *e.au.m*, external auditory meatus; *p.R*, incisura Rivini; *mt*, membrana tympani; *u*, umbo of the membrana tympani; *d*, pouch between the membrana tympani and the lower wall of the meatus; *i.au.m*, internal auditory meatus; *a*, and *b*, upper and lower divisions of the parts of the auditory nerve; *n.p*, canal for the posterior ampullary nerve; *ss.c*, ampulla of superior semicircular canal; *p*, posterior ampulla; *c*, common crus of the superior and posterior semicircular canals; *e.s.c*, external ampulla; *e'.s.c*, external semicircular canal; *s.t.c*, scala tympani cochleæ; *f.r*, fenestra rotunda, closed by the membrana tympani secundaria; *a.f*, aqueduct of Fallopius.

process of the incus is directed backward, and the processus gracilis of the malleus goes forward through the anterior wall of the tympanum.

The ossicles are said by Eugene Körner to have a dense cortical layer of firm bone lamellæ. The bone-corpuscles increase in size deeper in, and are especially large at the articular extremities. The malleus and incus have a medullary cavity in their long axes (Rüdinger), into which the converging Haversian canals empty. The articular cartilage of the malleo-incudal joint is from .912 to .916 millimetre thick (Körner).

The ossicular chain is held in position in the tympanum externally by

the membrana tympani, internally by the obturator ligament of the stapes, and posteriorly by the amphiarthrosis between the posterior tympanic wall and the end of the short process of the incus, and by two tendons, numerous ligaments, and folds of mucous membrane. Politzer gives the distance between the roof of the tympanum and the head of the malleus as five to six millimetres on an average. Klingel¹ gives measurements of the attic or cupola, which is the vault of the tympanic cavity, taken vertically from the incisura Rivini to the tegmen in forty-seven macerated bones. Four millimetres was the length most frequently found, and five to six millimetres was seen in but two specimens.

Ligaments of the Ossicular Chain. (Fig. 50.)—The anterior ligament

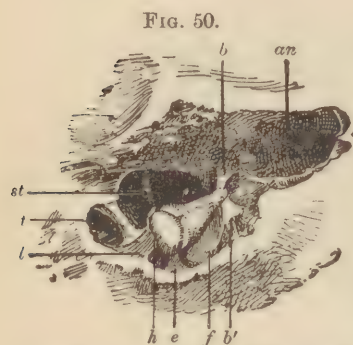


FIG. 50.
TYMPANIC CAVITY VIEWED FROM ABOVE AFTER REMOVAL OF THE TEGMEN, LEFT EAR (after Politzer).—*h*, head of the malleus; *l*, anterior ligament of the malleus; *e*, external ligament of the malleus; *f*, outer fold of the incus; *b'*, outer part of the posterior ligament of the incus; *b*, inner part of the posterior ligament of the incus; *t*, tendon of the tensor tympani muscle, with a webbing of its sheath along the anterior border; *st*, incudo-stapedial articulation; *an*, mastoid antrum.

of the malleus is a very strong band of tendinous fibres of different lengths. It is inserted on the anterior surface of the malleus from just above the insertion of the tensor tympani tendon to near the crown. The upper part of the insertion is marked by a deep depression in the head of the malleus. The long part of the ligament is attached about the base of the processus gracilis, and comes from the fissure of Glaser, arising partly from the spina angularis of the sphenoid bone and partly from the border of the Glaserian fissure. It surrounds the processus gracilis. The short fibres forming the upper part of the ligament arise from the inner and lower surface of the spina tympani major. This ligament resists most strongly the backward motion of the malleus; but by its size and strength and the shortness of

part of its fibres it resists any motion of much amplitude, except forward motion.

The *suspensory ligament* of the malleus (Fig. 47, *ls*) is very variable in strength and length. It is usually a slender band extending from the spina tegminis mastoidei to the highest part of the head of the malleus. This point is not the end of the long axis which passes through the head and manubrium, but it is to the inner side and behind it, very close to the articulation of the incus. It corresponds very nearly to the end of the axis which passes through the head and neck of the malleus. The fibres of the ligament spread down the inner side of the head of the malleus, and backward to the incus. It checks extreme downward and outward motion of the malleus and inward rotation of the manubrium.

¹ Archives of Otology, 1891.

The *external ligament* of the malleus (Fig. 50, *e*) is not invariably present. It is fan-shaped, with its apex inserted on the neck of the malleus from the anterior ligament to the articulation of the incus, following the crista colli or the superior posterior border of the external rhomboidal surface of the neck. The outer border of the ligament is attached along the border of the incisura Rivini. Its posterior border is much longer than the anterior. This ligament forms the roof of Prussak's space. It is thin, not very strong, and is often perforated between the rays of the fan. It checks outward motion of the manubrium, as it is attached above the axis of motion.

The *internal ligament* of the malleus (Fig. 50, *t*) is the sheath of the tensor tympani tendon. Its origin is the tip of the processus cochleariformis, and it is inserted into the malleus round the tendon, but mostly in front of it. Toynbee called this the tensor ligament of the membrana tympani. It resists outward motion of the handle of the malleus. The anterior border of this sheath is very strong, and is usually prolonged forward into a band of glistening fibres, spreading wider as they approach the malleus. It is attached along the base of the processus gracilis and the anterior ligament of the malleus. Occasionally some of the tendinous fibres leave the main bundle and are attached along with this ligament at the root of the processus gracilis.

The *mucous folds* of the malleus (Fig. 50) here described are not found in every tympanum, but occur in the majority. The *anterior mucous fold* extends between the suspensory ligament and the anterior ligament of the malleus and tegmen tympani. The *external fold* extends between the suspensory ligament, the head and the external ligament of the malleus, and the tegmen tympani. The *internal fold* is a strong horizontal band with a free internal border. It stretches from the lower toothed process of the incus forward along the lower inner and lower anterior borders of the head of the malleus and the inner surface of the anterior ligament of the malleus to the external end of the spina transversa tympani.

The *mucous fold* of the tendon of the tensor tympani is given off from the anterior border of the sheath of the tendon. The fold is double, having an upper and a lower part, which meet at the sheath, forming an acute angle. The lower part is nearly horizontal, and extends forward from the sheath of the tendon to the roof of the orifice of the osseous Eustachian tube, outward to the inner side of the anterior ligament of the malleus, the crista tympanica major, and the tympanic bone, and inward to the processus cochleariformis, the rostrum tubæ, and the crista tubæ or the prominent lower lamella of the processus cochleariformis. The upper part of the fold is more constant than the lower. It rises at an angle of about forty-five degrees from its posterior attachment to the sheath of the tendon, and is attached to the anterior ligament of the malleus, the spina transversa tympani (Fig. 51, *tpm*), and the rostrum cochleare.

Anterior to the superior part of the tensor tympani mucous fold, and sometimes bounded below by the inferior part of this fold, is a space some-

times of considerable size, the *anterior chamber of the tympanum*, bounding anteriorly the *cavum epytympanicum*.

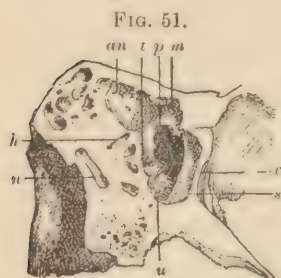


FIG. 51.
SAGITTAL SECTION THROUGH THE TYMPANUM AND ANTERIOR EDGE OF THE INNER END OF THE OSSEOUS MEATUS, RIGHT EAR (after Politzer).—*v*, section of the anterior lower wall of the meatus; *s*, sulcus tympanicus; *an*, mastoid antrum; *t*, *p*, *m*, spina transversa tympani, extending from the rostrum cochleare to the spina tympani major; *m*, cavity for the head of the malleus; *u*, lower wall of the tympanum; *h*, *n*, section of the semi-circular canals.

The *external mucous fold of the incus* is double, having an inferior and a superior part, starting posteriorly from the anterior border of the external part of the posterior ligament of the incus. The inferior part is nearly horizontal, and extends forward to the posterior border of the external ligament of the malleus and outward from the incus to the external tympanic wall and notch of Rivinus. The superior part is much higher along its external and anterior than along its internal and posterior border. Its plane varies in obliquity from forty-five degrees to ninety degrees. Its inner border follows the outer border of the dorsal aspect of the incus, and, crossing over the crest of the incus, it joins the mucous folds about the suspensory ligament of the malleus. Its outer border is attached to the outer or superior wall of the tympanum.

The following folds are more uncommon :

The angle formed by the long process of the incus and stapes with the manubrium is often webbed by the *inferior malleo-incudal fold*. The *posterior internal fold* extending from the short process of the incus to the inner and posterior tympanic wall and posterior part of the stapes is sometimes continued outward under the short process of the incus to the external wall or the fold of the posterior pocket. This fold is nearly horizontal. The *anterior malleo-incudal fold* extends between the tensor tympani tendon sheath, the malleus, the lower toothed and long processes of the incus, the stapes, and the inner wall of the tympanum. The *vertical fold of the tensor tympani* is a rare fold, extending from the tensor tympani tendon sheath to the tegmen between the head of the malleus and the inner wall.

The *membrana propria* of the stapes is a double mucous fold enclosing an air-space between the crura, the superior part of the fold covering over the upper borders of the crura, and the lower part of the fold extending over the lower borders of the crura, closing in the floor of the air-space. This *membrana propria* is very rarely intact, and is usually only a remnant. As a rule, the stapes is connected with the walls of the pelvis ovalis by mucous folds. This attachment is stronger to the lower wall of the pelvis, probably because this wall is nearer the stapes. The adhesions are formed usually by delicate fibres and bands.

The *mucous fold of the stapedius* stretches between the tendon of the stapedius, the posterior crus of the stapes, and the inner tympanic wall. The bony spiculæ extending from near the eminentia stapedii to the promontory are often furnished with a web of mucous membrane.

The sinus tympanicus is sometimes entirely covered over by mucous-membrane folds. The pelvis rotunda also often has mucous folds or striæ across it, and sometimes is completely covered over by them. Still more inconstant fibres and bands of mucous membrane connect the ossicula with one another and with the tympanic walls. The mucous folds are always most abundant from the upper and external surfaces of the ossicula.

The passage from the upper part of the tympanum to the lower is, as a rule, wholly cut off from the tendon of the tensor tympani muscle, in front of and external to the malleus and incus, back to the posterior ligament of the incus; and occasionally the tympanum is wholly divided on an irregular plane passing through the processes of the incus and tensor tympani tendon.

It is probable that these mucous folds are formed during the fœtal development of the tympanic cavity, and persist, becoming less abundant as age advances.

The mastoid antrum usually contains some mucous folds and striæ. These may be very numerous, and are often arranged radially from a central axis, extending to the dorsum of the incus.

Nerve-Supply of the Extrinsic Muscles of the Tympanum.—The tensor palati is supplied by a branch from the otic ganglion. The levator palati and the palato-pharyngeus are supplied by the descending palatine branches of Meckel's ganglion. These nerves are derived from the facial.

The *intrinsic muscles of the tympanum* are the musculus tensor tympani and the musculus stapedius.

The tensor tympani (Fig. 52, *s, t*) arises anteriorly from the greater wing of the sphenoid, the upper surface of the cartilaginous Eustachian tube, and the osseous wall of the petrous pyramid adjacent to the carotid canal; occasionally a connection exists with the tensor palati muscle either by muscular fibres or by fibrous tissue. The muscle arises posteriorly from the upper wall of its muscular canal. It is enclosed in a fibrous sheath. The tendon of this muscle lies on the under side of the belly, and leaves the belly just in front of the rostrum cochleare; it passes through the rostrum, turns almost at right angles, and, going across the tympanum, is attached to the inner surface of the malleus at the lower angle and adjacent anterior inferior border of the internal rhomboidal surface of the neck. It approaches the malleus in an oblique direction to the long axis of the manubrium. The muscle is two centimetres long or

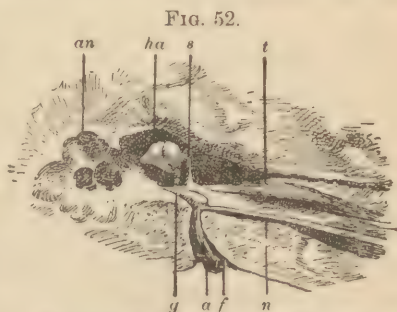
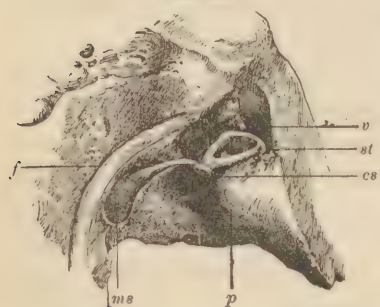


FIG. 52.
TYMPANIC CAVITY AFTER THE REMOVAL OF THE TEGMEN TYMPANI, AND SOME BONE ANTERIORLY, RIGHT EAR (after Politzer).—*ha*, malleo-incudal articulation; *t*, tensor tympani muscle; *s*, tendon of tensor tympani muscle passing across the tympanum; *f*, facial nerve; *g*, geniculate ganglion of the facial nerve; *n*, greater superficial petrosal nerve; *a*, auditory nerve; *an*, mastoid antrum.

more. The sheath of the tendon is covered by mucous membrane, and usually has a band of fibrous tissue along its anterior border, which I have called the internal ligament of the malleus. The sheath of the tendon was described by Toynbee as the tensor ligament, and is considered by Helmholtz as a continuation of the periosteum lining the muscular canal. The sheath is connected with the tendon by prolongations of connective tissue.

The action of the tensor tympani is first of all to draw the handle of the malleus and the membrana with it inward, thus rotating the malleus

FIG. 53.



POSTERIOR PART OF THE INNER TYMPANIC WALL, WITH THE POSTERIOR WALL PARTLY DISSECTED: TWICE NATURAL SIZE: RIGHT EAR (after Politzer).—*st*, stapes; *cs*, capitulum stapedis; *ms*, stapedius muscle in its canal and its tendon inserted at the neck of the stapes; *p*, promontory; *f*, facial nerve in the descending part of the aqueduct of Fallopius; *v*, an opening made into the vestibule.

on its axis of motion till the cogs of the malleo-incudal articulation interlock. Next it rotates the malleus and incus together on their common axis, pushing the stapes inward before the long process of the incus, and finally all the ossicula are drawn inward as far as their ligaments will allow.

The stapedius muscle (Figs. 53 and 54) has its tendon protruding from the apex of the eminentia pyramidalis on the posterior wall of the tympanic cavity. It is about seven millimetres long. The muscle is pyriform longitudinally and rounded or prismatic transversely. The fibres go upward to join the central tendon, which extends over half the length of the belly

of the muscle, the other end being attached to the stapes between the capitulum and the posterior crus. The belly of the muscle lies in the canal which is formed in the pars petrosa, internally to the descending part of the canalis Fallopii.

In the infant there is a considerable opening from the aqueduct of Fallopius into this muscular canal. In the adult this is reduced to one or more small fissures or a small foramen for the nerve of the stapedius. The chief action of the stapedius muscle is to lift the anterior part of the foot-plate of the stapes out of the oval window.

Nerve-Supply of the Intrinsic Tympanic Muscles.—The tensor tympani is supplied from the

motor portion of the fifth nerve through the branch of the otic ganglion to the muscle. The stapedius is supplied by a small branch from the facial

FIG. 54.



THE LEFT TYMPANIC CAVITY, FROM BELOW (after Politzer).—*t*, membrana tympani; *st*, stapes, with the tendon of the stapedius muscle attached; *v*, vestibule; *mi*, meatus auditorius internus.

nerve. Gellé¹ says that in cases of complete paralysis of the facial nerve the tympanic muscles still act, though they lose some of their power of coördination.

The *nerves* found in the tympanic cavity are the chorda tympani, which issues from the posterior canal of the cord on the posterior wall and follows along the pockets of the membrana, leaving the tympanum through the canal of Huguier. It does not give off any branches. The tympanic plexus ramifies over the promontory, radiating in various directions.

The *blood-supply* of the middle part of the ear comes from the external carotid chiefly, the internal carotid supplying but small arterioles. The ascending pharyngeal artery from the external carotid sends small branches to the Eustachian tube and the external muscles of the tympanum; it also supplies part of the lining of the tympanic cavity. The middle meningeal artery from the internal maxillary branch of the external carotid, before it enters the cranium, sends small branches to the Eustachian tube. Inside the skull it gives off the superficial petrosal branch, which enters the hiatus Fallopii and anastomoses with the stylo-mastoid artery. In the mucous membrane the vessels of the superficial layer send branches into the villi, and in the deep layer branches are given off which supply the bone. On the promontory the deep branches anastomose with branches from the labyrinth (Politzer). Some blood-vessels enter the tympanum through the petrosquamous fissure, and others enter from below and pass on to the promontory. The stylo-mastoid artery, from the posterior auricular branch of the external carotid, gives off some small branches inside the aqueduct of Fallopius, which supply the back part of the tympanum, the stapedius muscle, and the mastoid cells. Zuckerkandl found a constant small branch, the artery of the stapes, going to the stapes and the obturator membrane. This artery anastomoses with the artery of Jacobson's nerve on the promontory. It enters the tympanum through the anterior foramen of the cord and anastomoses in the periphery of the membrana with the arteria auricularis profunda. Small branches from the temporal artery of the external carotid enter the tympanic cavity through the Glaserian fissure. The internal carotid sends some small branches to the tympanum from inside the carotid canal. The arteria tympanica, a branch of the internal maxillary, enters the tympanum through the Glaserian fissure, and joins the stylo-mastoid artery in forming a vascular circle around the periphery of the membrana. It sends a branch to the external meatus, and anastomoses with the tympanic and Vidian branches of the internal carotid.

The *veins* of the *tympanum* empty into the pharyngeal veins and the veins of the maxillary articulation; the veins of the region of the promontory, together with those from the inner part of the ear, empty through the venæ auditoriæ internæ accompanying the artery of the same name through either direct branches or through the meningeal veins into the

¹ Annales des Maladies de l'Oreille, November, 1890.

inferior petrosal, transverse, or petro-squamous sinuses. Prussak says the arteries of the tympanum avoid anastomoses, and pass either directly into the veins or through very short capillaries; but the veins anastomose very freely. Politzer observed with the microscope that vascular connection is kept up between the middle ear and the labyrinth through the intervening osseous wall.

The *lymphatics* of the middle part of the ear drain into the glands of the pharynx and into the anterior and posterior auricular glands.

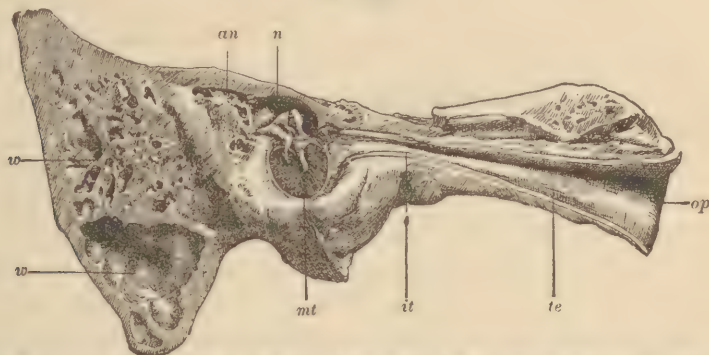
Nerve-Supply of the Tympanic Cavity.—The tympanic cavity is supplied by the glosso-pharyngeal, sympathetic, trigeminal, and facial nerves. Of these the glosso-pharyngeal branch, or Jacobson's nerve, is the most important. It arises from the petrous ganglion and passes from the jugular fossa, through the floor of the tympanum, upward over the face of the promontory, lying in small grooves and foramina, and forms the tympanic plexus. The branches of the nerve go to the fenestræ rotunda and ovalis, the mucous membrane of the Eustachian tube, and the tympanic cavity. It communicates below with the carotid plexus. Above it receives a branch from the facial nerve, called the lesser superficial petrosal nerve. This nerve passes through the canal named after it on its way to join the otic ganglion. Another branch of Jacobson's nerve goes upward and joins the greater superficial petrosal nerve in the hiatus Fallopii. The sympathetic branches pass through minute apertures in the carotid canal and enter the tympanic cavity to join the tympanic plexus. These small branches are called *nervi carotico-tympanici*. The tympanic plexus contains many ganglion-cells, and is an anastomosis of nerves from the otic, petrosal, and carotid ganglia. The Eustachian tube is supplied from this plexus with fibres from all its roots,—viz., sympathetic, Jacobson's, and lesser superficial petrosal nerves. The trigeminal nerve sends a branch from the otic ganglion to the Eustachian tube.

THE EUSTACHIAN TUBE.

The *Eustachian tube* is the passage between the naso-pharynx and the tympanic cavity (Figs. 55, 56, and 57), and is composed of two parts, an osseous and a membrano-cartilaginous, measuring, according to Politzer, altogether from thirty-three to forty millimetres in length and averaging thirty-five millimetres,—from ten to fifteen millimetres (Gruber) belonging to the osseous part. The two parts make a broadly obtuse angle with each other, opening forward and downward. The tympanic orifice of the tube lies posterior to and on a higher level than the pharyngeal orifice. The tube makes an angle of about forty degrees with the horizontal and about forty-five degrees with the mesial plane, and goes inward, forward, and downward. Schwalbe gives the anterior angle formed between the axis of the tube and the axis of the external meatus as one hundred and fifty degrees. The tympanic orifice measures three millimetres in breadth and five millimetres in height; the pharyngeal orifice measures ten to thirteen

millimetres (Gruber), and is bounded on the lateral wall of the pharynx by the free projecting end of the cartilage. The posterior wall of the tube

FIG. 55.

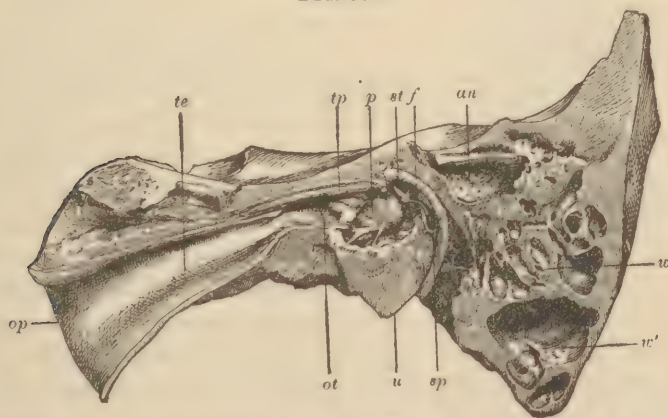


OUTER HALF OF SAGITTAL SECTION OF ENTIRE LEFT MIDDLE EAR (after Politzer).—*op*, ostium pharyngeum tubæ; *te*, Eustachian tube; *it*, isthmus tubæ; *mt*, membrana tympani, with the malleus and incus and the chorda tympani nerve; *n*, niche of the outer wall of the tympanum; *an*, mastoid antrum; *w, w*, mastoid cells.

forms the anterior wall of the fossa of Rosenmüller. Politzer gives the distance from the pharyngeal end of the tube to the membrana tympani and to the orifice of the antrum mastoideum as forty millimetres and forty-seven to forty-nine millimetres respectively.

The Eustachian tube extends downward, inward, and forward from the anterior wall of the tympanum to the side of the naso-pharynx. The osseous part of the Eustachian tube is bounded above and posteriorly by the processus cochleariformis, and below and on the inner side by the ca-

FIG. 56.



SAGITTAL SECTION OF THE ENTIRE MIDDLE EAR, INNER HALF OF LEFT EAR (after Politzer).—*op*, ostium pharyngeum tubæ; *te*, canalis tubæ Eustachii; *ot*, ostium tympanicum tubæ; *tp*, museulus tensor tympani; *p*, promontory, marked by the tympanic plexus; *u*, lower wall of the tympanum; *st*, stapes; *sp*, museulus stapedius; *f*, facial nerve; *an*, mastoid antrum; *w, w'*, mastoid cells.

rotid canal. The lumen at its narrowest point, which is near the junction with the cartilaginous tube, is called the *isthmus*, and is from one and one-

half to two millimetres high, and from one-half to three-quarters of a millimetre wide (Politzer). Between the extremities of the osseous tube Henle

FIG. 57.



CORROSION CAST OF THE RIGHT MIDDLE EAR (Politzer, after Bezold).—The cell-spaces of the mastoid process and antrum took an unusually small amount of the injecting mass.—*o*, ostium pharyngeum tubæ; *i*, isthmus tubæ; *ot*, ostium tympanicum tubæ; *u*, lower part of tympanic cavity; *t*, membrana tympani with the groove of the malleus; *h*, depression for the body of the malleus and incus; *a*, posterior end of the mastoid antrum; *e*, cells leading from the antrum to *te*, the lower cells of the mastoid process.

gives the diameter as two millimetres. On section the osseous tube is irregularly triangular.

The membrano-cartilaginous Eustachian tube is formed partly of fibro-cartilage and partly of fibrous tissue (Fig. 58).

FIG. 58.



MAGNIFIED TRANSVERSE SECTION THROUGH THE CARTILAGINOUS EUSTACHIAN TUBE (after Politzer).—*a*, vertical part of cartilaginous plate; *b*, cartilaginous hook; *c*, open space under the hook; *d*, floor of the tube; *e*, *e'*, folds of mucous membrane; *f*, cylindrical epithelium; *g*, musculus tensor palati; *h*, musculus levator palati; *i*, membranous part of tube.

The cartilaginous part is made of a triangular cartilaginous plate, a right angle forming the upper inner angle and the base the inner border. The lower border of the cartilage is concave, especially towards the inner end. The upper border of the cartilage is bent over anteriorly, forming a groove opening downward, and giving the cartilage its characteristic hooked appearance on transverse section. The hook of the cartilage is comparatively thin. The rest of the cartilage is slightly thicker, but narrows towards its lower border; and the inner end is the thicker, sloping to a point at the outer end.

The cartilage hangs nearly vertically suspended by its upper border to the base of the skull, the folded portion being unattached. The outer end of the cartilage is attached to the orifice of the osseous Eustachian tube, and the outer third is attached to the walls of the supplementary osseous tube formed by the inward continuation of the posterior wall of the osseous tube and the sphenoid bone. From this point inward the rounded upper surface of the cartilage is attached in the Eustachian groove on the

under surface of the sphenoid, in as far as the base of the inner pterygoid process. The attachment of the cartilage to the base of the skull is made by strong fibrous tissue, binding it to the periosteum and the basilar fibro-cartilage. Internally the attachment becomes narrower and less firm. Owing to this broad attachment, the upper part of the cartilage has no true perichondrium. The cartilage has fissures in various places which are bound together by strong fibrous tissue. The membranous part of the tube is a strong membranous curtain stretching from the lower free margin of the cartilage hook to the inner surface of the lower border of the vertical part of the cartilage, thus forming the floor and the outer or anterior wall of the tube, except the narrow upper strip of the anterior wall, which is formed by the cartilaginous hook. This membranous curtain is formed by a dense tunica propria, through which vessels go to the inner surface of the tube, and is continued below into the salpingo-pharyngeal fascia. It is thicker below than above. Its thickness increases outward also, where it receives additional fibres from the spina angularis of the sphenoid, together with a small cartilaginous rod. There is a layer of fat between the membranous wall and the palatine muscles. Accessory cartilages are sometimes found in the membranous as well as in the lower end of the cartilaginous portions and in the ligamentum salpingo-pharyngeum. The membrano-cartilaginous Eustachian tube is funnel-shaped, with its pharyngeal orifice the larger, and consequently the narrower end is where it joins the osseous tube. The pharyngeal end is oblique, the inferior internal wall extending farther inward than the superior external. The lumen of this end of the tube measures five millimetres in height and three millimetres in width (von Tröltsch): this orifice, however, is not clearly defined. The mucous membrane lining the tube joins that of the tympanum with that of the pharynx, and it is covered with cylindrical, ciliated epithelium. The cilia move from the tympanum to the pharynx. There are also basal and goblet cells (Schultze). At the ostium pharyngeum there are papillæ or villi on the mucous membrane of the median and lower walls.

The acinous mucous glands are most numerous at the pharyngeal end and on the cartilaginous wall. These glands extend to the neighborhood of the perichondrium, but sometimes, especially near the orifices in the pharynx, they can be traced, through fissures in the cartilage of the tube, into the connective tissue outside. Besides these glands Gerlach found abundant sebaceous glands through the whole cartilaginous tube, and in the adult a scanty adenoid tissue on the floor of the tube, which is called the *tonsil* of the tube. Towards the tympanum the mucous glands become less numerous, and the mucous membrane is more delicate, and is firmly united to the periosteum. On the anterior surface of the cartilaginous wall the submucous layer serves as perichondrium. There are several longitudinal vascular folds on the membranous wall of the pharyngeal end, which are probably smoothed out when the tube is distended. The lumen of the cartilaginous tube when at rest is closed by the apposition of the

cartilaginous and membranous walls, except at the top under the cartilaginous hook. Near the upper border of the lumen of the tube the mucous membrane forms two or more overlapping projections on the cartilaginous side, which probably aid in keeping the tube closed. In exceptional cases this canal is open the whole length of the tube. As a rule, the fissure between the two walls stands open at the pharyngeal orifice.

The infantile Eustachian tube differs from that of the adult. It is nineteen millimetres long (Eitelberg),—eleven millimetres in the cartilaginous and eight millimetres in the osseous part. The infantile is wider proportionately, is more nearly straight and horizontal, than the tube of the adult. The greater width is especially marked at the isthmus and the ostium tympanicum. The osseous portion is proportionately shorter than in the adult. The pharyngeal opening in the fœtus is below the plane of the hard palate, in the new-born it is in this plane, at four years it is three to four millimetres, and in the adult it is ten millimetres, above this plane (Kunkel). The pharyngeal opening is not so gaping and the cartilage does not project so far inward as in the adult.

The following table by Symington shows the length of the Eustachian tube at different ages :

Child, six weeks	17 millimetres.
“ one year	20 “
“ one and one-quarter years	20 “
“ two years	23 “
“ four and one-half years	31 “
“ five years	30 “
“ seven years	30 “

The *muscles of the Eustachian tube* are two or three in number. The lumen of the tube, the walls of which are in contact with each other, sometimes more, sometimes less intimately, is temporarily opened by a muscular apparatus. These muscles are the levator and tensor palati molliis and the palato-pharyngeus. The levator palati is an elongated rounded muscle lying on the outer side of the posterior nares. It arises from the under surface of the apex of the petrous portion of the temporal bone close to the entrance of the carotid canal. In the pharynx above the upper concave border of the superior constrictor it turns obliquely inward and downward and its fibres spread out on the upper surface of the soft palate and meet the muscle of the other side in the median line. The belly of the muscle lies parallel to the Eustachian tube, and is closely applied partly to the membranous portion which forms the base of the tube, and partly to the cartilaginous plate. It is attached to the tube by a short band only of connective tissue along the lower margin of the posterior surface of the tube. The action of the levator palati molliis is not confined to the velum palati, for by the shortening and swelling of its belly the base of the Eustachian tube is raised and the vertical cartilage is pressed inward, by which the orifice of the tube is made smaller in the vertical

diameter, but the resistance in the tube is lessened, owing to the widening of its aperture.

The action of the palato-pharyngeus chiefly concerns the pharynx, but as it often has a branch, called the salpingo-pharyngeus, which is attached to the Eustachian tube, it may be of considerable functional importance in the movement of the tube. The salpingo-pharyngeus is a continuation upwards of the palato-pharyngeus, and it is attached to the lower part of the cartilaginous and membranous walls of the membrano-cartilaginous Eustachian tube. The palato-pharyngeus is a long and slender muscle, forming the posterior pillar of the fauces. It arises from the soft palate by an expanded origin, which is divided by the levator palati and azygos uvulæ, and meets the muscle of the opposite side in the middle line. The muscle passes outward and downward behind the tonsil and is inserted after joining the stylo-pharyngeus into the posterior border of the thyroid cartilage. The action of the salpingo-pharyngeus is to draw the vertical cartilage and the membranous wall of the tube backward and inward. Acting in concert with the levator palati it possibly aids in increasing the lumen of the tube.

The tensor palati or adductor tubæ is the most important of the tubal muscles. It is a broad, thin muscle lying on the outer side of the levator palati, and has a vertical and a horizontal part. The vertical portion arises in a broad band from the scaphoid fossa at the base of the internal pterygoid plate, from the inner aspect of the spine of the sphenoid, and from the vaginal process of the temporal bone. The cartilaginous part of the Eustachian tube lies immediately behind its origin, and some fibres of the muscle arise from the wide lower border of the folded part of the cartilage, and occasionally some may arise from the membranous part. Descending vertically, it forms an acute angle with the direction of the membrano-cartilaginous tube, and terminates in a tendon which passes round the hamular process of the sphenoid, where it is lubricated by a synovial membrane. In its downward course its flat belly lies close to the lateral wall of the membranous portion of the tube, and is rather firmly attached to it. The tendon of the horizontal portion then passes inward and spreads out on the anterior surface of the soft palate, joining the tendon of the muscle of the opposite side in the median line, and is attached in front to the ridge on the palate bone. By the contraction of this muscle the cartilaginous hook and the membranous part of the tube are drawn downward and forward, and in this way the lumen of the tube is widened.

THE INTERNAL EAR.

Membranous Labyrinth.—The histology and minute anatomy of this region, especially of the scala media, have not been determined with absolute accuracy. The membranous labyrinth includes the membranous structure lying within the osseous labyrinth. It is partly surrounded by a

space containing lymphatic fluid called perilymph, while it contains a fluid called endolymph. Its form corresponds in general outline to that of the osseous labyrinth, but it is much smaller. The *perilymphatic spaces* are covered by a layer of fine fibrillated connective tissue destitute of elastic fibres, but containing many nuclei. This is covered by endothelium. The membrane serves the purpose of serous membrane on one side, and periosteum on the other, where it is in contact with the bone. This membrane covers the membranous labyrinth wherever it is not attached, as well as the osseous walls of the perilymphatic space. In accomplishing this it forms a lining in the vestibule making a large space adjacent to the foot-plate of the stapes, called the *cisterna perilymphatica*, which is about three millimetres deep from the stapes inward and about three and one-half millimetres from before backward. A tube of the membrane goes from the vestibule, through the semicircular canals, to the vestibule again. From the vestibule the membrane is continued also into the cochlea through the wide opening of the scala vestibuli, and lines the scala up to the cupola, where, through the *helicotrema*, it communicates, according to most authorities, with the scala tympanica, lining this scala also. The helicotrema is a narrow space bounded by the lamina modioli, which is the termination of the modiulus, by the hamulus Scarpæ, which is the terminal process of the lamina spiralis ossea, and by the *lagna*, which is the blind end of the scala media. At the lower end of the scala tympani the perilymphatic membrane forms a blind pouch. Near this extremity on the outer wall the membrane lines the inner surface of the *membrana tympani secundaria* of the round window. Slightly above the round window on the outer wall of the scala tympani, the perilymphatic membrane leads into a narrow membranous tube, the *ductus perilymphaticus*, which lies in the aqueduct of the cochlea and empties into the arachnoid space at the lower posterior border of the petrous bone. Thus the subarachnoid space and the perilymphatic sac communicate. The *membrana tympani secundaria* looks backward, downward, and outward; it is attached to the irregular margin of the fenestra rotunda, lying at the bottom of the pelvis rotunda. It is somewhat cordate, with nearly equal diameters, having a rounded convex outer or anterior border, and a concave inner or posterior border. The membrane does not lie flat, but is folded along its inner border to fit the undulations of the inner border of the osseous window. The chief fold of the membrane is concave outward, lying nearly horizontally across the centre of the membrane, but fading away as it extends outward. This principal fold divides the membrane into a larger superior and a smaller inferior segment. The plane of the lower segment is nearly parallel to the lamina spiralis, and that of the upper segment or the *membrana* is nearly at right angles to the long axis of the scala. The inferior segment is flat or slightly convex outward, and the superior segment is strongly concave outward. As a whole the *membrana* is markedly concave outward, owing to the deep groove mentioned above. The membrane is composed of a

connective tissue *membrana propria* with fibres radiating from the apex of the curve of the *membrana*. Externally it is covered by thin mucous membrane, and internally by endothelium. Owing to its form, it probably cannot give way very much inward, but may act as a safety-valve in case of too great tension of the labyrinthine fluid.

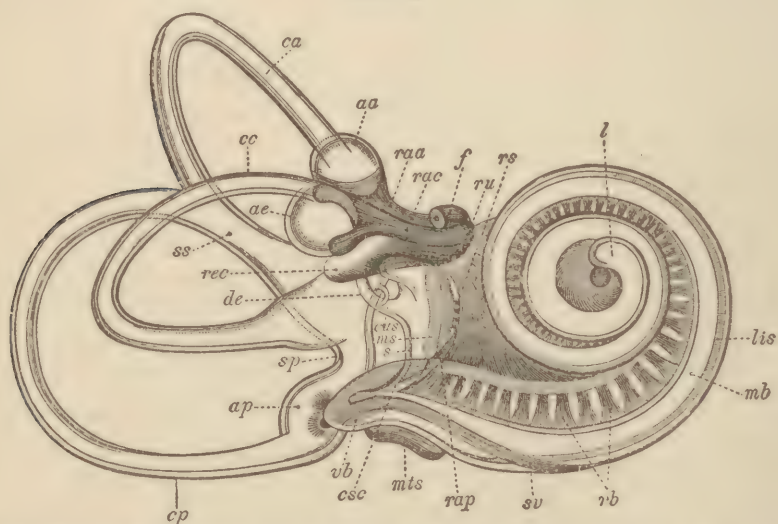
The *endolymphatic sac*, or *true membranous labyrinth*, is lined with epithelium, and is surrounded by the *perilymphatic sac*, except where it is attached to the osseous walls. The sac has three chief parts, connected only by narrow tubes. Two of these are placed in the vestibule. One, the *utricle*, sends branches into the semicircular canals and communicates with the other one, the *sacculæ*, through the forked end of the *ductus endolymphaticus*. The other one of the three parts of the endolymphatic space is the *scala media of the cochlea*, which communicates with the *sacculæ* through the *ductus reuniens*. The *scala media* lies between the *perilymphatic scalæ* of the vestibule and tympanum on two sides and the outer wall of the cochlea on the third side. The endolymphatic sac, like the *perilymphatic sac*, communicates with the cerebral lymph-spaces through a narrow tube, called the *ductus endolymphaticus*, which lies in the *aqueductus vestibuli* and opens into a sac in the *dura mater* on the posterior surface of the petrous pyramid. This sac, called the *recessus Cotugnii*, is from five to nine millimetres broad and from eight to fifteen millimetres long. From this recess many small canals are supposed to radiate, communicating with the lymphatic spaces of the *dura mater*.

The walls of the *sacculæ* of the vestibule are made up of a fibrous layer most strongly marked near the *maculæ*, and a structureless hyaline membrane, and are covered by pavement epithelium which runs into the neuro-epithelium at the *maculæ* and may contain pigment. The *utricle* is oblong, compressed laterally, measuring about three by one and a half or two millimetres, with its long axis directed downward and backward. It occupies the upper and back part of the vestibule, lying on the *fossa semi-elliptica*. It opens posteriorly into the semicircular canals through five openings. It is fastened to the osseous wall by bands of loose connective tissue, except below and near the foot-plate of the stapes. Its anterior superior extremity is enlarged into the *recessus utriculi*. The posterior superior extremity, called the *sinus superior*, is drawn out into the common canal of the posterior and superior osseous semicircular canals and leads into the common membranous canal. The posterior inferior extremity is prolonged as a tube about one millimetre in diameter and length, called the *sinus posterior* of the *utricle*; this opens into the posterior ampulla. The other ampullæ open into the upper anterior part of the *recessus utriculi*. The *utricular arm* of the *ductus endolymphaticus* opens from the *utricle* near the orifice of the superior and posterior semicircular canals. The *macula acustica* of the *utricle* and of the *sacculæ* are the same in structure. In the *utricle* it is an opaque yellow thickened spot from two to four millimetres in diameter (Politzer), which is placed on the inner side of the recess

away from but facing the stapes, and is attached to the osseous wall. The epithelium lining the utricle passes into the neuro-epithelium of the macula, which is formed by auditory cells and filiform cells. The auditory cells are bottle-shaped, bulging in the middle, and are provided with from ten to fifteen auditory hairs at their free extremities, from twenty to twenty-five micro-millimetres long. The cells are from thirty-six to forty micro-millimetres long (Gruber). The nucleus is elliptical and lies in the large part of the cell. The vestibular nerve ramifies in the deep layers of the macula and sends non-medullated fibres to the base of the epithelium. These form a mass of fibres surrounding the base and sides of the hair cells. The epithelium is covered by a clear semi-fluid substance, resembling, some say, the membrana tectoria of Corti's organ, which coagulates after death (Steinbrügge), forming an enveloping membrane over the otoliths. The otoliths are crystals of carbonate of lime, containing vacuoles, and are from one to five micro-millimetres long. The otoliths make the macula opaque.

The *membranous semicircular canals* (Fig. 59) resemble the osseous in

FIG. 59.



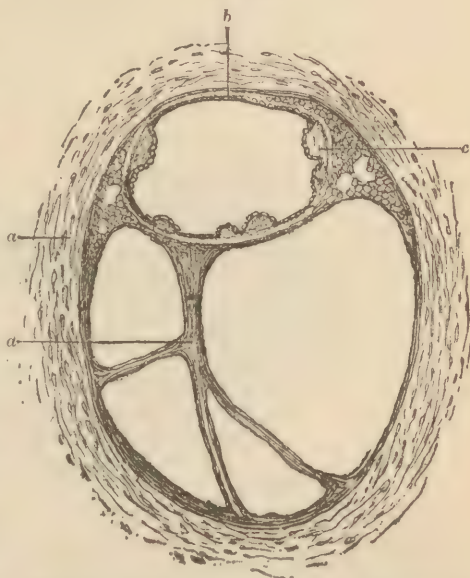
THE MEMBRANOUS LABYRINTH OF THE RIGHT EAR OF A MAN TWENTY-FIVE YEARS OLD, SEEN FROM THE OUTER AND ANTERIOR ASPECT, five times enlarged; osmic acid preparation (Gruber, after Retzius). —*lis*, ligamentum spirale; *mb*, membrana basilaris; *l*, lagena; *rb*, ramulus basilaris; *sv*, stria vascularis; *rap*, ramulus ampullae posterioris; *rs*, ramulus sacculi; *ru*, ramulus recessus utriculi; *f*, nervus facialis; *mts*, membrana tympani secundaria; *csc*, canalis reuniens at the inferior extremity of the saccule; *s*, saccule; *ms*, macula acustica sacculi; *cus*, canalis utriculo-saccularis; *de*, ductus endolymphaticus of the aqueductus vestibuli; *sp*, sinus utriculi posterior; *rec*, recessus utriculi; *raa*, ramulus ampullae superioris; *rac*, ramulus ampullae exterioris; *aa*, ampulla superior; *ae*, ampulla exterior; *ap*, ampulla posterior; *rb*, caecum vestibuli; *ca*, canalis semicircularis superior; *cc*, canalis semicircularis externus; *cp*, canalis semicircularis posterior; *ss*, sinus utriculi superior, or common limb of the superior and posterior semicircular canals.

shape and number, except that the ampullae are larger in proportion than in the osseous, and the diameter of the membranous canals is about one-third that of the osseous. These canals do not float freely within the osseous

ones, but are strongly attached (Fig. 60) all along the convexity of their loops to the osseous wall. They also have scattered vascular bands going to the inner wall of the loop, called *ligamenta canaliculorum*. The ampullæ are named after the canals to which they belong. Each ampulla has what corresponds to the macula acustica of the sacculus, forming an elevation on its inner surface called the *crista acustica*. This extending across the side of the ampulla is continuous with the convex wall of the arch of the semicircular canal, where there is a deep furrow on the outer surface through which the ampullary nerve enters. The epithelium of the cristæ appears to be identical with that of the maculæ. The crista divides the ampulla into a shorter part next to the utricle, called the sinus, and a longer one, called the tubular portion. The epithelium of the ampulla becomes long and cylindrical on the border of the crista, which is covered by neuro-epithelium like that on the maculæ acusticæ. The greatest diameter of the ampulla is two to two and a half millimetres. The membranous canals have a diameter of from three-tenths to fifty-eight hundredths of a millimetre. The superior and external ampullæ are connected by a common opening into the recessus utriculi, and the posterior ampulla opens into the posterior sinus of the utricle. The inner surface of the canals (Fig. 60) on the free walls is studded with numerous small elevations covered with epithelium. These are wanting on the adherent part of the canals and near the utricle. Nerve-elements have not been found in the semicircular canals.

The *sacculæ* is attached on its inner side to the *fovea hemisphærica* by connective tissue and by the nerve-fibres which enter the vestibule through the lamina cribrosa superior and supply the *macula acustica* of the sacculæ. This macula acustica measures from two and one-half to three millimetres in length, and is one and a half millimetres broad (Gruber). The outer and inner walls of the sacculæ are concave outward, and the inner wall is the thinner. This wall is attached above to the under surface of the recessus utriculi near where it communicates with the utricle. The outer wall of the sacculæ gives off superiorly a diverticulum called the *sinus*

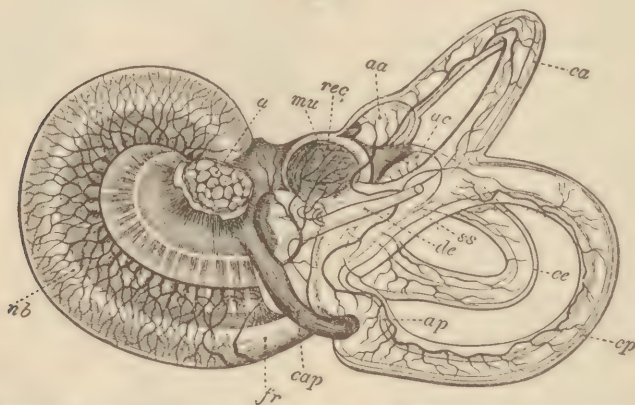
FIG. 60.



SECTION THROUGH THE OSSEOUS AND MEMBRANOUS SEMICIRCULAR CANALS (after Politzer).—*a*, osseous semicircular canal; *b*, place of attachment of the membranous semicircular canal; *c*, elevations on the inner surface of the membranous semicircular canal; *d*, vascular bands of connective tissue.

utricularis, which is attached above to the under side of the recessus utriculi close to its opening into the utricle: this sinus is directed backward and outward. Low down in the outer wall of the saccule there is the funnel-shaped opening of the saccular branch of the *ductus endolymphaticus*. The ductus endolymphaticus is formed by two roots, one from the saccule and one from the utricle, and is directed upward and backward along the

FIG. 61.



RIGHT MEMBRANOUS LABYRINTH OF A FŒTUS OF THE FIFTH MONTH, SURROUNDED BY ITS PERILYMPHATIC TISSUE, SEEN FROM ITS POSTERIOR AND INTERNAL ASPECT, five times enlarged: osmic acid and carmine preparation (Gruber, after Retzius).—*ca*, superior semicircular canal; *cp*, posterior semicircular canal; *ce*, external semicircular canal; *aa*, ampulla superior; *ac*, ampulla externa; *ap*, ampulla posterior; *ss*, common crus of the superior and posterior semicircular canals; *de*, ductus endolymphaticus; *rec*, recessus utriculi; *mu*, macula acustica recessus utriculi; *a*, nervus acusticus; *cap*, ramulus ampullae posterioris; *fr*, position of fenestra rotunda; *nb*, membrana basilaris.

inner side of the utricle, continuing on behind the sinus superior of the utricle and passing to the recessus Cotugnii through the aqueductus vestibuli. The *canalis reuniens* opens from the saccule at its lower part and goes into the scala media nearly at right angles. It is about seven-tenths of a millimetre long, has a diameter of about twenty-two hundredths of a millimetre, and its walls are about fifteen thousandths of a millimetre thick.

In describing the cochlea it is treated as a distinct pyramidal object with a base and apex, without any reference to the planes of the body.

The Membranous Cochlea (Fig. 62).—Along the free border of the lamina spiralis on its vestibular surface the periosteum or lining of the bony cochlea becomes thickened, forming the *limbus laminae spiralis*, or *crista spiralis*, which decreases in extent towards the cupola. The free edge of the limbus is concave, forming the *suleus spiralis*. The edge of the sulcus towards the scala vestibuli is called the *labium vestibulare*, and the edge towards the scala tympanica the *labium tympanicum*. The labium vestibulare is serrated, forming the *auditory teeth of Huschke*, which are nipple-like projections along the free border of the labium. Between the teeth there are furrows, varying in shape, filled with nucleated cells. These auditory teeth are most developed in the basal coil

of the cochlea, and their number has been estimated by Retzius at seven thousand. The sulcus spiralis is covered by a soft mass of connective tissue pierced by capillaries and containing many branching and fusiform cells.

From the labium tympanicum the membrana basilaris extends to the outer wall of the cochlea, thus connecting it with the lamina spiralis, and forming the tympanic wall of the scala media. The

length of the tympanic wall is about thirty-three and a half millimetres, and it increases in width as it approaches the cupola.

Where the basilar membrane reaches the outer wall it spreads out, forming a fibrous structure, the *ligamentum spirale*. The ligamentum spirale forms a ridge along the outer surface of the cochlea from

below the attachment of the basilar membrane to above Reissner's membrane. It is composed of fibrous tis-

sue radiating mostly from the point of attachment of the membrana basilaris. Near the inner border of the limbus the delicate membrane of Reissner rises from the vestibular surface and stretches at an oblique angle from the lamina to the outer wall, thus forming the vestibular wall of the scala media. The space included between the basilar membrane, the membrane of Reissner, and the stria vascularis or surface of the ligamentum spirale is called *scala media*, *spiral canal*, or *canalis membranacea cochleæ*.

Reissner's membrane is a thin homogeneous membrane, containing scattered spindle-cells, and covered towards the scala vestibuli by endothelial cells. The other or tympanic surface is covered by polygonal pavement epithelium which in some places forms projecting masses. The space on the outer wall of the cochlea between the attachments of the basilar membrane and Reissner's membrane is called the *stria vascularis*, and is made up of fibrous tissue containing many blood-vessels. It is attached to the periosteum, and is covered by pavement epithelium with fibrillated bases: these cells often contain pigment. It is really a continuation upward of the ligamentum spirale, which thins out gradually as it rises. On the stria vascularis there is a ridge running parallel to the ligamentum spirale, called the *crista ligamenti spiralis*, and the concavity between them is called the *sulcus ligamenti spiralis*. The scala media is about thirty-six millimetres

FIG. 62.

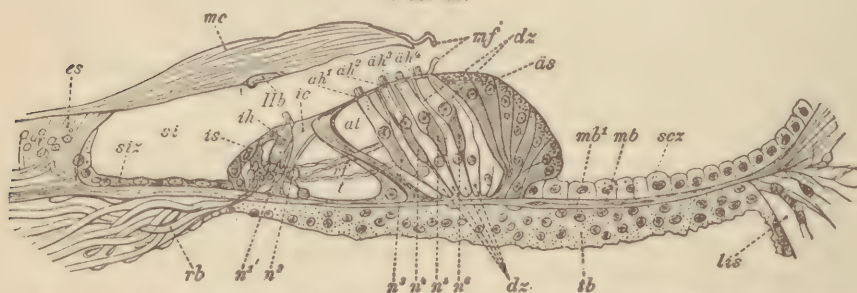


SECTION THROUGH THE LOWER TURN OF THE COCHLEA OF A NEW-BORN INFANT (after Politzer).—*sc v*, scala vestibuli; *sc t*, scala tympanica; *k*, lamina spiralis ossea; *b*, membrana basilaris; *l*, ligamentum triangulare; *R*, membrana Reissneri; *cc*, scala media; *o*, Corti's organ; *m*, Corti's membrane; *n*, fasciculus of the ramus cochleæ; *gs*, ganglion spirale.

long, but according to Retzius the tympanic wall is thirty-three and one-half millimetres long and considerably wider below than above. The scala vestibuli lies on the vestibular or upper side of Reissner's membrane, and the scala tympani on the tympanic or lower side of the basilar membrane. The lower extremity of the scala media is a cul-de-sac, called the *pars vestibuli*, or *cæcum vestibuli*: here the lamina spiralis membranacea, or basilar membrane, fills the fissura vestibuli (Fig. 14, *F*), and the canalis reuniens opens on the upper and inner surface near the end of the cul-de-sac. The upper end of the scala media has a blind extremity, called the *lagena*, which rests by its tympanic wall on the lamina modioli. The scala media makes nearly three spiral turns parallel to the lamina spiralis. The first turn is called the *basal coil*, the last the *apex coil*, and the middle the *central coil*. The basal coil is triangular on section, and the apex coil is more elliptical.

The membrana basilaris (Fig. 63), as before stated, stretches from the

FIG. 63.



TRANSVERSE VERTICAL SECTION OF CORTI'S ORGAN OF A MAN TWENTY-NINE YEARS OLD (Gruber, after Retzius).—*es*, limbus laminae spiralis; *mc*, membrana tectoria; *Hb*, Hensen's striae; *mf*, fibres of attachment of the membrana tectoria to the zona tecta; *st*, sulcus spiralis; *is*, inner supporting cells; *ic*, inner rod cells in connection with the outer rod cells, between which is seen the *t*, tunnel of Corti; *ih*, inner hair cell; *ah*, *ah'*, outer hair cells; *dz*, Deiters' cells; *as*, Hensen's supporting cells; *rb*, nerve-fibres of the ramulus basilaris; *n*, *n'*, outer bundles of the spiral nerve-fibres; *rf*, radiating tunnel fibres; *al*, inner part of Nuel's space; *mb*, upper layer of the membrana basilaris; *mb'*, lower layer of the membrana basilaris; *tb*, layer covering the tympanic surface of the membrana basilaris; *lis*, ligamentum spirale.

labium tympanicum of the sulcus spiralis to the ligamentum spirale, and consists of a foundation of tightly-stretched fibres going from the lamina spiralis to the ligamentum spirale: these fibres increase in length towards the upper end of the scala, as the basilar membrane increases in width. At the base the basilar membrane is two-tenths of a millimetre or less in width, and at the apex of the cochlea one-half of a millimetre; and it is thirty-five millimetres long (Randall). V. Hensen gives its width at two hundred and sixty-two thousandths of a millimetre from the lower end as forty-one thousandths of a millimetre. These fibres have been estimated at from thirteen thousand to twenty-four thousand in number. They are brought into close relation with the neuro-epithelium, as will be seen. The tympanic surface of the basement membrane is covered by a thick layer of protoplasmic cells. The basilar membrane, for convenience, may be divided

into three zones,—the inner, called the *zona perforata*, the middle, the *zona tecta*, and the outer, the *zona pectinata*.

The *zona perforata* is pierced by the spiral nerve-fibres coming from the foramina between the plates of the lamina spiralis ossea as they go upward and outward and come out again as simple axis-cylinders on their way to the neuro-epithelium. Retzius estimates the number of nerve-canals here at about four thousand; they are less numerous in the basilar turn than above. The epithelial covering of the medial side of this zone and the adjacent *suleus spiralis* is made up of quadrangular cells.

The Zona Tecta, Corti's Organ, or Papilla Acustica.—At the outer border of the *zona perforata* the epithelium becomes raised and columnar, forming the inner supporting cells of the *papilla acustica*; below these cells the nerves form some ganglionic enlargements. Next outward there is a single row of ciliated neuro-epithelial cells running parallel to the scala, called the *inner ciliated* or *hair cells*. The hair cells of the *papilla acustica* are arranged in two sets,—the set now under consideration, and the outer set, which is a row of ciliated cells three to five deep. The ciliated cells are long, comparatively narrow, and taper in the middle to a filiform basal extremity attached to the basilar membrane. This extremity is called *Gottstein's basal process*, and is connected with the fine nerve-filaments of the cochlear nerve. The nucleus is placed about the centre of the cell, and the part below it is very granular. The upper free extremity of the cell is truncated and furnished with about twenty hairs or cilia, stiff and glossy, and shorter than the hairs of the *maculæ* and *cristæ acusticæ*. They are directed towards the centre of the *scala media*, and are placed in a crescent, with the concavity directed inward. There is a cylindrical body lying in the free end of these cells. The external and internal ciliated cells are estimated at about two thousand by Waldeyer.

Corti's rods come next in the epithelial series going outward. They have been estimated at three thousand, and are arranged in two parallel rows running longitudinally on the basilar membrane. These rows have their bases some distance apart, enclosing the *zona arcuata*, which is forty-eight micro-millimetres broad in the basal and ninety micro-millimetres in the apex coil,¹ but as the rods converge their extremities are in contact, forming *Corti's arch*. Thus the closed tunnel of Corti is formed, running the whole length of the *papilla acustica*. The nerve-fibres going outward to the outer ciliated cells pass between the bodies of the rods.

Corti's rods are unicellular structures, partly modified to form the rod, which is surrounded by the protoplasm; the structure of the rod is finely grained and fibrous. Laskowski supposed them to be contractile. The size of Corti's inner rods increases from forty-eight micro-millimetres in the basal to seventy micro-millimetres in the upper coil, and the outer rods

¹ Hensen gives the width of this zone as 0.019 millimetre at the *fenestra rotunda* and 0.085 at the *lagna*.

from sixty-two micro-millimetres to one hundred and three micro-millimetres. Hensen gives the measurements of the rods as forty-eight thousandths of a millimetre at the fenestra rotunda, and at the lagena eighty-five thousandths of a millimetre for the inner and ninety-eight thousandths for the outer rods. The inner rods rise from a foot-plate which lies on the basilar membrane externally to the zona perforata and is continued outward on the floor of the tunnel and contains the cell-nuclei. The rod-like portion of the cell rises from the basilar membrane by a broad base internal to the nucleated portion. It passes upward and outward at an angle of about sixty degrees, becoming narrower and occupying nearly the whole of this end of the cell. The head or upper end of the rod broadens out and contains on the side adjacent to the rods of the other row a rounded homogeneous body. The head is concave on the inner side, to receive the inner hair cells, which are only about half as numerous as the rods; and a process from a rod projects inward between two adjacent hair cells. On the outer surface of the head of the inner rod there is a concavity, to receive the head of the outer rod; and, as there are more outer rods than inner, an inner one supports two or three outer ones. The upper angle of the inner rod is prolonged upward and outward to the first row of outer hair cells. The outer rods in general resemble the inner, except that they have their nuclei and most of their protoplasmic part on the inner side, and that they lean inward instead of outward. Waldeyer estimated these rods at four thousand five hundred. They form an angle of about forty degrees with the basilar membrane. The head is four-sided, and the two lateral sides touch the adjacent rods. The inner surface is convex, to fit into the concavity of an inner rod, and the outer surface is concave. The head is overlapped by the plate prolonged from the head of an inner rod. A process projects outward from the superior external angle of the head of the outer rod, to which is attached the first segment or phalanx of the lamina reticularis. This process spreads out between the adjacent outer hair cells of the first row, ending at the second row of outer hair cells. The rods of the basilar coil are shorter than those near the cupola.

The outer hair cells resemble the inner ones and are in four or five parallel rows. They are connected with the auditory nerve in the same way. These cells stand nearly erect on the basilar membrane, and consequently a triangular space lies between them and the slanting outer rods of Corti. This space is roofed over by the lamina reticulata, and is called *Nuel's space*. Both Corti's tunnel and Nuel's space are closed spaces according to Retzius, but have processes ramifying between the cells of the papilla acustica and communicating freely with each other between the outer rods and hair cells.

It seems probable from the researches of pathology that the basal coil of the cochlea serves for the perception of high tones, and the apex for that of low tones. This suggests that the function of the fibres of the basilar membrane which are shorter below and longer above may

have to do with the perception of tone. The hair cells are in close relation to these fibres, and are in the proportion of about two fibres to each hair cell. Alternating with the rows of outer hair cells, and lying parallel to them on their outer sides, there are rows of inverted club-shaped nucleated cells, attached by their large extremities to the basilar membrane. They are in close contact with Corti's cells, and are called Deiters's cells. They sometimes contain pigment. The upper extremities of these cells are attached to the reticular membrane. A glistening fibre extends from one end of the cell to the other, called the supporting fibre, and lies on the inner side of the cell: the fibre is attached to the basilar membrane; its upper end terminates in a flat phalangeal process, which is a thin plate having a clear margin. The edges of the phalanges are connected, and with the hamular process of the inner and the phalanx of the outer Corti's rod form the *lamina reticulata*. The connections of the phalanges leave meshes for the reception of the upper ends of the outer hair cells, which are attached in the openings. Viewed from above, this membrane appears to be made up of constricted oblong plates.

Corti's membrane, or *membrana tectoria*, is a thick gelatinous membrane resembling that covering the maculæ acusticæ, except that it has no otoliths. It arises from between the membrana Reissneri and the labium vestibulare of the sulcus spiralis, and extends outward to the outer row of outer hair cells. It is not known whether this membrane roofs over or is in contact with the hairs of Corti's cells, or whether its outer border is in contact with the outer border of the hair cells or with the ligamentum spirale, or with neither. It has an inner and an outer zone. The inner zone is thin and adherent to the epithelium of the limbus. The outer zone projects outward and upward over the sulcus spiralis and papilla acustica. It is thickest in the middle. At the lower end the free margin is glistening; in its central course it is thick, and in the apex it is thin and fibrous, the fibres projecting over the outermost hair cells. In the middle of the under surface of the membrana tectoria there is a glistening band, *Hensen's stripe*, running longitudinally. It is firm and striated in structure. This membrane, together with the basilar membrane, papilla acustica, and limbus spiralis, encloses a space called the *ductus cochleæ*.

On the outer side of the outermost of Deiters's cells there are tall columnar epithelial cells, called the *supporting cells of Hensen*. These have a spherical nucleus at about the centre of the cell, contain pigment-granules, and are attached below by narrowed extremities to the basilar membrane. These cells quickly shorten as we approach the zona tecta, which is covered on its scala-medial side by short columnar cells containing round nuclei and pigment and resting on the fibrous layer of the basilar membrane. The zona pectinata increases in width from twenty-three thousandths of a millimetre at the base to forty-one hundredths of a millimetre at the apex (Hensen).

Terminations of the Fibres of the Auditory Nerve.—Bipolar cells are found

in the branches of the auditory nerve. The fibres of the auditory nerve at first have a myeline sheath and a sheath of Schwann. The nerve-fibres lose both sheaths before they enter the maculæ and cristæ acusticæ, and, passing through the epithelium as axis-cylinders, they are attached to the lower ends of the hair cells. The fibres supplying the basilar membrane come from the lamina spiralis ossea, anastomose, and proceed through the labium tympanicum to the zona perforata. They are naked axis-cylinders when they emerge from the zona perforata, and pass upward and outward, dividing into fine fibrillæ; these twist to form the inner spiral fasciculus, which sends fibrillæ up to the lower ends of the inner hair cells, round which the fibrillæ form a net-work and then end in the cells. Some of the fibrillæ pass out between the inner rods into Corti's tunnel, and form the second spiral fasciculus at the lower ends of these rods. From this fasciculus fibres go upward and outward to the outer rods and pass between them into Nuel's space. The fibres cross this space and join the outer spiral fasciculus on the inner side of the external ciliated cells. Each row of hair cells is provided with a fasciculus like this, and from these fasciculi the fibrillæ join the lower ends of the bodies of the outer hair cells.

Blood-Vessels of the Labyrinth.—The internal auditory artery, a branch of the basilar artery, or sometimes of the anterior cerebral, accompanies the auditory nerve. At the bottom of the internal meatus it divides into the cochlear and vestibular branches. The vestibular branch supplies the vestibule and semicircular canals. The cochlear branch sends branches to the modiolus, the spiral canal, and the membranous part of the cochlea. The cochlear branch subdivides into numerous branches which pass through the tractus spiralis foraminatus into the modiolus, and, passing out through the lamina spiralis to the contents and walls of the cochlea, form anastomoses with one another on both sides of the lamina spiralis. The vestibular branch, which divides into small branches, passes through the posterior wall of the vestibule to its soft tissues. A branch goes into each end of the semicircular canals and anastomoses when it meets the branch from the other end.

The stylo-mastoid artery sometimes gives twigs through the Fallopian canal to the semicircular canals and cochlea (Triquet).

The *veins* of the labyrinth either empty by means of the vena auditoria interna which accompanies the internal auditory artery, or directly into the neighboring sinuses, the inferior and superior petrosal, transverse, and petrosquamosal sinuses. The blood from the vestibule and semicircular canals returns through the vena aquæductus vestibuli, which empties into the superior petrosal sinus. The blood from the cochlea flows back through the vena aquæductus cochleæ into the internal jugular vein. The existence of veins of the aqueducts is questioned (Gruber). The tympanic and labyrinthine vessels communicate through the intervening osseous wall.

The *lymphatics* of the labyrinth communicate with both those of the cranium and those of the middle ear.

THE AUDITORY NERVE.

The auditory nerve leaves the medulla by two roots, anterior and posterior. The anterior root enters the brain at the level of the lateral fossa of the bulb. It goes obliquely backward and inward and passes between the restiform body and the inferior root of the trigeminal, and then divides into two groups of fibres, one internal and the other external. The internal fibres lose themselves in a mass of gray substance which lies on the floor of the fourth ventricle in the region called the external white tract. This poorly-defined mass of gray substance extends to the neighborhood of the medial raphé and forms the internal nucleus of the auditory nerve. The external fibres go outward, ending at some small masses of gray substance irregularly distributed throughout the restiform body and posterior pyramid; together these bits of gray substance form the internal nucleus of the auditory nerve. The nerve-fibres that come in contact with this nucleus, probably, however, cross it only in order to reach the cerebellum by following the inner side of the inferior peduncle of the cerebrum.

The posterior root goes round the restiform body from before backward, and thus arrives on the floor of the fourth ventricle. Some of these fibres, called the deep fibres, end in the internal nucleus of the auditory nerve. The rest, called the superficial fibres, are very loose and divergent; they make up the beard of the calamus. These fibres reach the median line and end in a group of little nuclei which arrange themselves on each side of the raphé between the pillar of the hypoglossal and the eminentia teres. These little nuclei, which are Clarke's innominate nuclei, belong to the radical group of the auditory nerve. They can be called, from their position, the median nucleus of the auditory nerve. The anterior nucleus of the auditory nerve is made up of a little mass of gray substance which is situated on the external side of the anterior root of the auditory nerve, in front of the restiform body. From its situation and its relation to the auditory nerve, this ganglion has been compared to the spinal ganglia.

The relations of the anterior ganglion of the auditory nerve are very obscure. All that can be said is that it varies in different parts. The lower part contains cells resembling those of the motor tracts. The upper part of the ganglion contains cells resembling most closely the cells of the spiral or Gasserian ganglion.

Huguenin describes the cells as follows. Their form is round and vesicular, with but few prolongations, and they are thin and very fine. The cells are covered with a very delicate cellular envelope, containing small nuclei. A naked protoplasm lies inside this envelope, containing a rounded nucleus of moderate size, containing a number of nucleoli. These cells measure from fifteen to twenty-one thousandths of a millimetre.

The auditory nerve contains no motor fibres. The anterior root of the nerve arises from the medulla in the lateral depression immediately behind the protuberance slightly to the outside of the facial and the intermediary

nerves, and is shaped like a little flattened rod. The posterior root arises from the floor of the fourth ventricle by some fibres called the beard of the calamus scriptorius, and winds around the restiform body to join the anterior root. The auditory nerve then goes obliquely outward, forward, and upward, winds across the inferior peduncle of the cerebellum, along the inner crus of the lobule of the pneumogastric, and enters the internal auditory meatus in a sheath formed by the arachnoid and pia mater. Through its whole course as far as the labyrinth the auditory nerve is accompanied by the facial and the intermediary nerve of Wrisberg. (The intermediary nerve is supposed to be the upper extremity of the chorda tympani before it joins the facial nerve.) The three nerves are bound together by connective tissue, and they proceed in a common sheath of the arachnoid which conducts them to the bottom of the internal auditory meatus. Luciani states that the auditory centre is found in the cornu Ammonis besides in the temporal lobe. Each auditory nerve communicates with both auditory centres, each containing a decussating and a smaller non-decussating fasciculus.

The Peripheral Course of the Auditory Nerve.—The auditory nerve divides, at the bottom of the internal osseous meatus, anteriorly into the larger and inferior cochlear and posteriorly into the smaller and higher vestibular nerves. These nerves contain ganglion-cells throughout their course. The chief groups of these are the intumescencia ganglioformis of the vestibular branch, at the bottom of the internal auditory canal, and the ganglion spirale of the cochlear branch, which lies in the spiral canal. The vestibular nerve has three branches, the superior, middle, and inferior. The superior branch supplies the utricle and the ampulla of the external and superior semicircular canals. It passes through the bone, coming out at the macula cribrosa of the recessus. The middle branch supplies the saccule. The inferior branch supplies the ampulla of the posterior semicircular canal.

The two main branches of the auditory nerve are histologically different. The vestibular, or posterior superior, is made up of voluminous fibres, while the anterior inferior or cochlear part is composed of relatively slender fibres. The auditory nerve contains many ganglion-cells, distributed throughout, either singly or in varying groups. Politzer states that there is an anastomotic connection between the ramus vestibuli and the ramulus sacculi.

The cochlear division passes through the tractus spiralis foraminosus to the first convolution of the cochlea and the nerve-channels of the modiolus, and thence to the lamina spiralis. Before leaving the modiolus the nerve-fibres are provided with the ganglion spirale. In the lamina spiralis the nerve-fibres become non-medullated and have extensive anastomoses; reaching the zona perforata from between the two layers of the lamina spiralis ossea, and passing up through the basilar membrane, they divide into very fine terminal fibres which are in contact with Corti's hair cells.

NERVES IN AND ABOUT THE TYMPANUM. (Fig. 64.)

The sphenopalatine ganglion of the superior maxillary nerve receives a posterior branch, called the Vidian nerve. It is an afferent nerve coming through the Vidian canal. Going backward over this nerve, one finds it passes up through the foramen lacerum anterior and is joined by a branch from the carotid plexus. The nerve then goes outward and backward and enters a little furrow on the anterior surface of the petrous bone, and divides into the great superficial petrosal and the great deep petrosal. The great superficial petrosal enters the hiatus of Fallopius and joins the geniculate ganglion of the facial. The other branch, the great deep petrosal, goes into the petrous bone, enters the tympanum, and joins Jacobson's nerve on the promontory.

The otic ganglion of the superior maxillary nerve is placed on the outer side of the nerve just after its exit from the foramen ovale. This ganglion has both efferent and afferent branches, four in all. The lesser superficial petrosal nerve is a motor branch of this ganglion; it comes from the geniculate ganglion of the facial, passes out into the anterior surface of the petrous bone through a special foramen coming out of the cranial cavity through a small orifice between the foramen ovale and the foramen spinosum, and enters the posterior side of the otic ganglion. The sensory branch of the ganglion is a branch given off on the promontory of the tympanum from Jacobson's nerve, a branch of the glosso-pharyngeal. It pierces the tympanic wall as a fine filament, and leaves the anterior surface of the petrous bone from a small foramen a little behind the hiatus Fallopii and joins the lesser superficial petrosal. A sympathetic fibre reaches the otic ganglion from the middle meningeal artery.

Of the efferent branches of the otic ganglion (Fig. 65) there is a motor nerve to the tensor tympani muscle; this filament has a small ganglion near the muscle. Several sensory branches from the otic ganglion are attached first to the auriculo-temporal nerve, and then separating from it are distributed to the mucous membrane of the tympanic cavity. The otic ganglion sends a plexiform branch containing ganglion cells to the chorda tympani nerve.

FIG. 64.

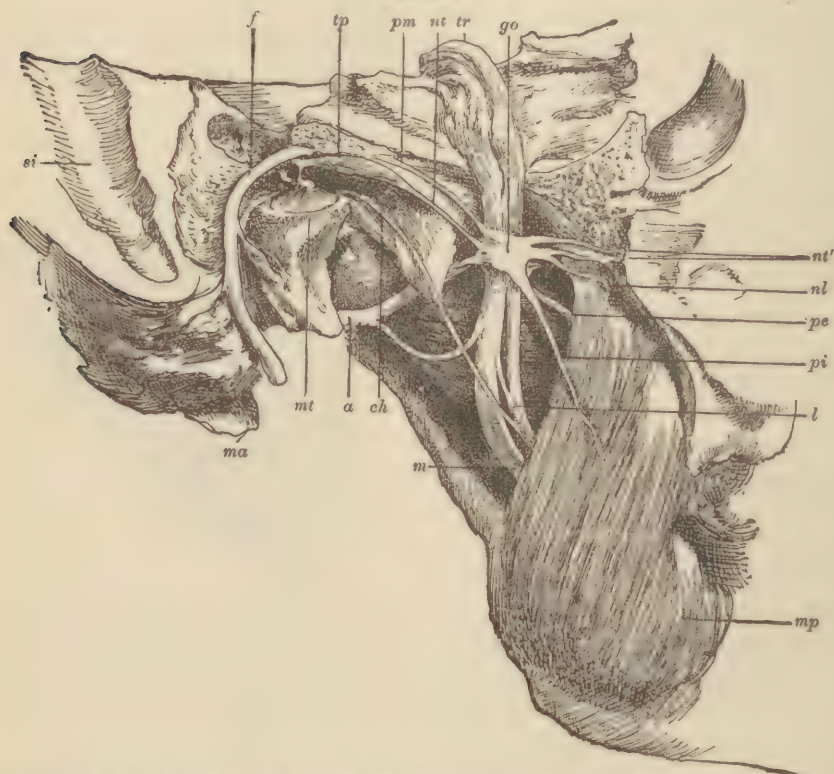


NERVES IN AND ABOUT THE TYMPANUM (Burnett, after Heath).—1, sensory portion of the fifth nerve, with Gasserian ganglion; 2, tensor tympani muscle; 3, motor portion of the fifth nerve passing beneath the ganglion; 4, malleus; 5, small superficial petrosal nerve (Arnold's); 6, incus; 7, otic ganglion; 8, facial nerve; 9, chorda tympani nerve; 10, membrana tympani; 11, musculus tensor palati; 12, middle meningeal artery; 13, 13, lingual nerve; 14, auriculo-temporal nerve; 15, inferior dental nerve; 16, musculus pterygoideus externus; 17, musculus pterygoideus internus; 18, internal maxillary artery; 20, 20, mylo-hyoid nerve.

The submaxillary ganglion of the lingual nerve is placed above the submaxillary gland. It receives several afferent branches from the lingual, consisting partly of fibres of the chorda tympani nerve and partly of lingual fibres. The ganglion also receives a sympathetic branch from the facial artery. Efferent fibres are distributed to the submaxillary gland.

The facial nerve together with the intermediary nerve of Wrisberg and the auditory nerve enters the internal auditory meatus and there receives the

FIG. 65.



DISSECTION OF THE LEFT OTIC GANGLION AND ITS BRANCHES (after Politzer).—*tr.* trigeminal nerve and Gasserian ganglion; *go*, otic ganglion; *nt'*, nervus tensoris palati; *nl*, nervus levatoris palati; *pe*, nervus pterygoidei externi; *pi*, nervus pterygoidei interni; *tp*, musculus tensoris tympani; *nt*, nervus tensoris tympani; *pm*, nervus petrosus superficialis minor; *m*, internal maxillary nerve; *ch*, chorda tympani nerve; *l*, lingual nerve anastomosing with the chorda tympani; *a*, nervus auriculo-temporalis; *f*, facial nerve; *mt*, inner surface of the membrana tympani; *ma*, mastoid process; *si*, sigmoid sinus; *mp*, internal pterygoid muscle.

intermediary nerve. When the facial nerve in its passage from the internal auditory meatus through the aqueduct of Fallopius reaches the hiatus of Fallopius, it forms the geniculate ganglion. The branches of the facial in the aqueduct going peripherally are the greater and lesser superficial petrosals, the nerve of the stapedius muscle, and the chorda tympani, which is a continuation of the intermediary nerve and consequently a branch to the pneumogastric. The greater superficial petrosal is a motor nerve; it is given off from the geniculate ganglion, and goes to make up the Vidian

nerve and the sphenopalatine ganglion. The lesser superficial petrosal is also a motor nerve; it is given off also from the geniculate ganglion, and ends in the otic ganglion. The chorda tympani nerve is given off from the facial a short distance above the stylo-mastoid foramen. Taking a backward course, the chorda tympani goes upward and forward, and, passing through the posterior canal of the cord, emerges in the tympanic cavity in its upper posterior part. It then traverses the tympanic cavity from behind forward, passing along the fold of the posterior pocket of the membrana tympani, between the manubrium of the malleus and the long process of the incus, and then along the base of the fold of the anterior pocket, and leaves the tympanum through the anterior canal of the cord, or canal of Huguier, which is really the inner part of the fissure of Glaser. From this point the cord approaches the lingual nerve, which it joins at an acute angle. After this union the course of the cord is the same as that of the lingual nerve, till it separates to form the submaxillary ganglion. The fibres go first to the submaxillary and sublingual glands, and then to the mucous membrane of the anterior half of the tongue. The submaxillary gland is supposed to receive most of its fibres from the chorda tympani.

The branch of the pneumogastric and facial called Arnold's nerve arises from the ganglion of the root of the pneumogastric and is connected with the petrous ganglion of the glosso-pharyngeal. It is given off from the facial at about the same place as the chorda tympani. It also communicates with the posterior auricular branch of the facial. From the facial this nerve goes backward through a small canal in the jugular fossa. It is generally supposed that this nerve-branch is composed of motor fibres from the facial and of sensory fibres from the pneumogastric. These sensory fibres follow along to the tympanic membrane and are lost in the skin covering the membrana and the upper wall of the external meatus.

The facial nerve anastomoses with the auriculo-temporal in the parotid gland anterior to the cartilaginous auditory meatus. At its exit from the posterior lacerated foramen the glosso-pharyngeal nerve has a small ganglionic enlargement, called either the ganglion of Andersch or petrosal ganglion. From near this ganglion the glosso-pharyngeal sends communicating branches to the pneumogastric, the facial, and the sympathetic nerves, and also gives off Jacobson's nerve.

Jacobson's nerve arises from the anterior surface of the petrous ganglion and enters Jacobson's canal, which carries it into the tympanic cavity, where it follows along a furrow or canal rising over the surface of the inner wall of the tympanum and soon divides into six branches, each branch lying in a little furrow. Two of these branches go backward, two more upward, and two forward. The two posterior branches, which are very slender, go to the mucous membrane of the tympanum, one to the vicinity of the round window and the other to the oval window. Of the two anterior branches, one goes to the mucous membrane of the Eustachian tube; the other, passing through a special foramen into the carotid canal, is lost in the

sympathetic plexus of the internal carotid. This branch is usually called the carotico-tympanic. The two superior branches of Jacobson's nerve pass through special canals in the petrous bone and come out on its anterior surface. The more internal of these branches, under the name of the greater deep petrosal, joins the greater superficial petrosal, which goes to make up the Vidian nerve and ends in the sphenopalatine ganglion, making one of its sensory roots. The more external of these two branches of Jacobson's nerve, under the name of the lesser deep petrosal, joins the lesser superficial petrosal and goes to the otic ganglion, forming one of its sensory roots. These branches and Jacobson's nerve form together the tympanic plexus, which is provided with scattered ganglion cells. Out of the six branches of Jacobson's nerve three supply mucous membrane and three join ganglia, one of which is a sympathetic ganglion and two are ganglia of the trigeminus. These anastomoses unite the petrous ganglion on one side with the carotid plexus, and on the other with the sphenopalatine ganglion of the superior maxillary and the otic ganglion of the inferior maxillary nerve. The tympanic plexus also sometimes receives a branch from the chorda tympani nerve.

The pneumogastric nerve, besides others, has anastomoses with the glosso-pharyngeal and with the facial through Arnold's nerve.

The Gasserian ganglion of the trigeminal nerve rests on the apex of the anterior surface of the petrous bone.

SINUSES.

The sinuses which are in connection with the temporal bone are the lateral or sigmoid, superficial and inferior petrosal, and petro-squamosal.

The lateral sinus begins at the internal occipital protuberance, and passes along the occipital bone over the mastoid angle of the parietal bone on to the mastoid portion of the temporal, where it begins to form an S-shaped curve, becoming the sigmoid sinus; it then passes on to the jugular process of the occipital bone and ends in the bulb of the internal jugular vein.

Branch veins from the sigmoid sinus pierce the skull through the mastoid and posterior condyloid foramina.

The superior petrosal sinus opens from the cavernous sinus, goes backward and outward along the superior border of the petrous bone, and empties into the sigmoid sinus.

The inferior petrosal sinus lies in a groove between the basilar process of the occipital bone and the petrous portion of the temporal bone. It connects the cavernous sinus and the bulb of the jugular vein.

The petro-squamosal sinus runs backward along the petro-squamous suture, and empties along with the superior petrosal sinus into the sigmoid sinus.

PART II. PHYSIOLOGY.

THE EXTERNAL EAR.

In man the pinna is not as important an aid to hearing as it is in most of the lower animals, where it is more movable or possesses a greater area to collect sound-waves. In man a large protruding pinna is probably functionally more useful than a small artistic one. The function of the pinna is chiefly to act as a reflector of sound-waves into the meatus, but it acts also as a conductor of sound, transmitting vibrations directly to the wall of the meatus. The concha is the most important part of the auricle for directing sound-waves into the external meatus. The rest of the auricle is of very little value. The concavity on the posterior surface of the tragus, which really forms a part of the concavity of the concha, is also of considerable importance in this respect. Politzer has shown that filling up these concavities lessens perception of sound, whereas increasing the concavity by mechanical means increases the perception. However, the pinna is not an indispensable part of the hearing apparatus, for in cases of absence of the pinna where the rest of the mechanism is intact, no perceptible loss of hearing occurs.

The auricular muscles are of little or no functional importance in man. Sexton has demonstrated that the tension of the membrana tympani is increased by traction on the auricle of the fascia connected with the external meatus: this is normally done in many individuals by involuntary action of the extrinsic auricular muscles.

The location and direction of sound are probably determined in a variety of ways: partly by the greater intensity of the sound perceived by the ear which is nearest the source of sound, which is increased by the involuntary movements of the head of the person attempting to locate the source of the sound; perhaps also partly by the perceptive power of the membrana tympani, which can determine on what portion of its surface the sound-waves impinge with greatest force, acting much in the same manner as the eye in determining the direction of the source of light. The power to do this is probably due to the sensibility of the membrana tympani; perhaps also to the auricle, for by directing the sound-waves it increases the accuracy of the perception of the membrana. When the membrana is destroyed it is conjectured that the tympanic walls serve the same purpose to some extent. The following is a recent theory. The angle at which the sound-waves strike the membrana tympani is dependent on the angle of incidence of the waves as they strike on the concha. Owing to the concavo-convex surface of the membrana (Pierre Bonnier),¹ any sound-waves falling on the

¹ *Comptes-Rendus de l'Académie de Science*, 1891.

membrana would move the manubrium in conformity to their direction, whether oblique or not. These movements, or their equivalents, may be transmitted to the stapes; and perhaps the direction thus given to the wave-point of the perilymph is perceived by the perceptive apparatus, thus giving the brain an index by which direction of sound can be determined. When the head is fixed, sounds directly in front of and directly behind the listener can readily be distinguished and accurately placed. Sounds coming from in front can always be heard most distinctly: this is well shown by the unconscious turning of the face of the attentive listener towards the source of sound. The distance of sound, or sound-perspective, is determined by the tone or quality for very distant or familiar sounds; but the eye is a very important adjunct to the appreciation of sound-perspective, especially when the sound is an unfamiliar one.

Audition can be either monaural or biaural. The head and the sounding body being in the same relative position, biaural audition is never less in intensity than monaural. The greatest biaural intensity, and consequently the greatest intensity of all, is given by sound in the mesial plane coming from in front. The intensity gradually decreases as the direction is changed to the mesial plane behind, where it is least.

In monaural audition, the sounding body being on the same side as the listening ear, the intensity is greatest when the sound-waves impinge at right angles on the front of the pinna, and least when the sound comes from behind. When the sound is directed at right angles to the mesial plane the hearing is monaural, or rather the biaural is equal to the monaural. However, when there are other sounds, besides the one sought for, coming from the side opposite to the chief sound, closure of the distant ear increases the perception of the chief sound by keeping out the other sounds from the distant ear: so that, among opposite lateral sounds, the perception of any one is increased by the monaural audition in the ear nearest the source of sound.

The external auditory canal carries the sound-waves from the pinna to the membrana tympani. The meatus performs its function very well, other things being equal, even when nearly closed either by foreign bodies or by the conformation of its walls. The expectant listener often stands with his mouth open; this is probably for two reasons, chiefly to lessen the respiratory sound by breathing through the mouth, and secondly to open the external meatus as wide as possible, which is accomplished by moving the head of the jaw forward. The bulging of the posterior wall of the cartilaginous canal just inside the meatus is of probable importance in collecting sound-waves reflected from the posterior surface of the tragus, and reflecting them again towards the concavity of the lower anterior wall of the osseous canal, this surface reflecting the waves on to the membrana. Doubtless much of the force of sound-waves which do not pass directly along the meatus to the membrana is lost by their being reflected, although the curvatures of the reflecting surfaces may focus the wave-force. If sounds within the

head, such as circulatory tinnitus, can be distinguished by the ear alone from sounds coming from without, it is probable that the perception is due to the tactile sense of the *membrana tympani*.

The *membrana tympani* is a tightly-stretched membrane, and consequently peculiarly well adapted to the transmission of wave-motion which it receives from the air contained in the outer meatus. These impulses are directly communicated to the handle of the malleus because of its intimate connection with the drum membrane, and are passed through the incus and stapes to the perilymph lying in contact with the foot-plate of the stapes. The sound-vibrations received from without are condensed by the mechanism of the ear, so that they arrive in the labyrinth with their force much increased. This end is accomplished in two ways: first, the relation of the area of the drum membrane and the foot-plate of the stapes is such that the receiving surface of the drum is in proportion to the area of the transmitting surface of the stapes as fifteen or twenty to one. The *membrana tympani* measures about nine to ten millimetres vertically and seven and a half to nine millimetres horizontally, and the foot-plate of the stapes about one and a half by three millimetres. Secondly, the leverage of the ossicles causes a force applied at the end of the manubrium to be increased one and one-half times (Helmholtz) when it is transmitted by the long process of the incus to the head of the stapes. The amplitude of the motion, of course, is proportionately lessened. Buck has shown that the vibrations of the ossicles stimulated by condensation and rarefaction of the air of the external meatus are twice as extensive in the malleus as in the incus, and four times as extensive as those in the stapes. According to Helmholtz's measurements, the greatest excursion of the stapes is one-eighteenth to one-fourteenth of a millimetre. The excursions of the ossicula caused by sound-waves must be very small, and for weak sounds practically imperceptible to the eye.

MOTIONS OF THE OSSICULA.

When the handle of the malleus moves outward the head moves inward, the axis of motion lying externally to the neck; and, as the greater bulk of the malleus is above this axis, the centre of the malleus moves inward. The motion in the malleo-incudal joint is greatest during the outward and return oscillation of the manubrium; during the inward oscillation the cogs of the joint interlock and prevent much motion. The return of the malleus is chiefly brought about by the tension of the ligaments.

When the manubrium oscillates inward, the head of the malleus oscillates outward, and the centre of the malleus also goes outward. The crown of the incus follows the head of the malleus inward when the manubrium goes outward, and follows it outward when the manubrium goes inward. The centre of the incus makes quite a large excursion, as the bone is fixed only at the tips of the processes. The articulation of the tip of the short process of the incus with the tympanic wall allows some rotation around

the axis of the short process, and also some motion in a vertical plane. The motion in the incudo-stapedial articulation is not extensive, but it can take place in both vertical and horizontal planes. The lenticular process of the incus during outward motion of the manubrium is drawn outward as far as the attachment of the stapes in the oval window will allow,—which is very little,—and is also pushed downward. During inward motion of the manubrium the lenticular process moves inward as far as the stapes will allow, and then upward. The motion of the foot-plate of the stapes is very slight. It swings outward and inward, using the inferior posterior border as a fulcrum. In conformity with this motion of the foot-plate, the head of the stapes describes an arc upward and downward, or backward and forward on the lower posterior border of the oval window as a centre. When the head of the stapes is pushed in and lifted up, the stapes swings inward on its lower border; and when the capitulum is drawn outward and downward, the foot-plate swings outward on its lower border. The motion of the long process when unattached to the stapes is inward and outward parallel to the manubrium; when attached to the stapes the inward and outward motion is checked, and is converted into a slight inward and outward motion and a more considerable upward and downward motion. The motion of the body of the incus inward and outward with the opposite motion of the manubrium is to a certain extent a safeguard to the oval window: thus a great force which otherwise would be applied to the foot-plate of the stapes is diverted, and expends itself in moving the body of the incus. The malleus can move outward several times farther when the incudo-stapedial joint is cut. When the manubrium is extended, *i.e.*, drawn outward, the malleo-incudal articulation is relaxed, and the apposition of the malleus and incus lessened. In this condition feeble tones of the middle and upper part of the scale are not heard much feebler than usual, but stronger tones are very sensibly diminished and all deep tones are damped. This may be due, as Helmholtz suggests, to the fact that the joint is too loose to transmit strong vibrations or those requiring large amplitude for their perception. But when the manubrium is flexed, *i.e.*, drawn in, the joint ligaments become tense and the bones are held in firm apposition, letting the vibrations pass along without interruption.

Mach and Kessel, from observations on the vibrating membrana tympani by the stroboscopic method, state that during the rarefaction stage of the sound-wave an annular fold goes from the umbo towards the periphery of the membrana, the wave going back from the periphery to the umbo during the condensation stage of the sound-wave. They observed, further, that the posterior segment of the membrana has greater excursions than the anterior.

The membrana causes the malleus to vibrate, the limit of whose motion is set by the tension of its ligaments and of the membrana, as well as by the malleo-incudal articulation and tensor tympani muscle. The vibration of the ossicles meets with some resistance from the articular and peripheral

ligaments and the mucous folds attached to the ossicles. These slight checks tend to regulate the vibrations and consequently aid the clearness of perception. Politzer has shown by experiments on anatomical preparations that the vibrations of the ossicula for low tones is less than for tones above the middle range, the vibrations decreasing in amplitude again for very high tones. Also, if the ossicula are weighted comparatively greater vibrations occur for the high than for the low tones. Also the vibrations for spoken words are comparatively less than for musical tones. When the membrana tympani is weighted, the vibrations of the ossicles decrease slightly, but if the ossicles are weighted to the same extent the amplitude of their vibrations is considerably diminished. The remarkable property possessed by the membrana tympani of transmitting so great a variety of tones and several different ones at the same time without emphasizing a fundamental one of its own is due to its curved surface and also to the non-elastic character of the membrane. This non-elastic character is of great importance in preventing after-vibrations, which would impair the distinctness of the perception of sounds. The drum membrane is also aided in this respect by the weight of the chain of ossicles, which causes the vibrations to cease quickly after an impulse, by muffling them. Blake has shown that the weight of the ossicles is disposed about the axis of motion in the proportion of eighteen to seven, the eighteen being above. This counterbalance would be a strong check to pendular vibrations of the membrana. The tensor tympani and stapedius muscles probably both act as dampers, but it is also probable that their chief action is accommodation. The stapedius especially is adapted for accommodation to the perception of faint sounds. The tensor tympani makes the membrana tympani more tense by drawing it inward, and also presses the stapes inward, consequent upon the inward motion of the long process of the incus: thus the tension of the inner labyrinthine fluid is increased. Pollak's experiments show that the tensor tympani muscle in the living animal responds to each tone-stimulation by a contraction which is stronger for the higher tones. These contractions cease entirely after the cochlea has been destroyed. In anatomical preparations he showed that on testing with a deep-toned tuning-fork the over-tones were made more predominant by contraction of the tensor tympani muscle. The stapedius pulls the foot-plate out of the oval window, or rather tilts the foot-plate outward on its posterior edge, and thus lessens the tension of the intra-labyrinthine fluids; and outward pressure of the stapes on the incus lessens the tension of the membrana tympani by pushing the manubrium slightly outward. The action of the tympanic muscles is antagonistic, and may serve to keep the articular surfaces of the ossicula in close apposition.

During the act of swallowing, the Eustachian tube is opened by the contraction of the palate muscles, and the tension of the air in the tympanic cavity equalizes itself with the tension in the vault of the pharynx. During the act of swallowing, if the nose is closed, a slight vacuum is formed in the

vault of the pharynx and is communicated to the tympanic cavity, the vacuum remaining in the tympanum till another act of swallowing relieves it. The Eustachian tubes are not formed in a way to resist much pressure of air from the pharynx, consequently in forced expiration with the nose and mouth closed, air is driven into the tympanum. A certain amount of this over-pressure remains in the tympanum after the expiratory effort has ceased, which is relieved during the act of swallowing or yawning. Much less force is required to open the tube from the tympanic than from the pharyngeal end.

Politzer has shown by experiment that increased pressure of air in the tympanum drives the membrana tympani outward, and increases the tension of the fluid in the labyrinth, and does not lessen it, as might have been expected, by drawing the stapes outward; also that on rarefaction of the air of the tympanum the membrana tympani is pushed inward and the tension of the labyrinthine fluid is lessened, and not increased, as might have been expected owing to the pressure inward of the stapes consequent upon the inward motion of the handle of the malleus. This change of tension in the labyrinth is ascribed to the movements of the membrana tympani secundaria, although on closing the round window with wax the changes of density of the intra-labyrinthine fluids continued as before, only to a less degree. When the incus is separated from the stapes the changes of pressure in the labyrinth are considerably increased. The explanation of the fact that during the extreme variations of the intra-tympanic tension the hearing for low tones is more impeded than for high, is that the more tightly stretched membrana conducts the high tones more readily than the low ones.

THE PROTECTIVE APPARATUS.

The protective apparatus of the ear is quite complicated. The tympanic cavity and inner part of the ear are protected from violence in a number of ways. The curve of the external meatus prevents an object's going straight in. The hairs of the meatus keep out small objects or dust. The cerumen, owing to its adhesive qualities, prevents insects from wandering at large about the meatus, and also attaches any small object to the side of the meatus, whence it is gradually extruded by the growth of the epidermis outward, and is meanwhile prevented from rolling about in the meatus.

The membrana tympani is a great protection to the more delicate parts lying within. The tensor tympani muscle protects the oval window and labyrinth from any too violent traction on the stapes due to loud sounds or other causes, and the stapedius muscle prevents the stapes from being driven into the oval window too violently. The stapedius muscle acts by lifting the anterior end of the foot-plate out of the oval window, the posterior end acting as the fulcrum. Both these muscles acting together tend to hold the ossicula rigid in the normal position. These muscles are unconsciously set in vigorous contraction when a violent shock about the head is expected; and not infrequently one or both of them are under control of the will.

The air of the tympanic cavity needs to be kept in equilibrium with the outer air for the proper discharge of the functions of the auditory mechanism. This is regulated by the opening of the Eustachian tube which is consequent on ordinary contraction of the palatine muscles, such as occurs in swallowing, yawning, and the like. This function, therefore, is always indirectly under the control of volition, and it is often directly so, some people having the power of opening their Eustachian tubes at will by special action of the palatine muscles. The large air-space of the tympanic cavity is considerably increased by the cellular spaces of the mastoid. This large reservoir helps to preserve the proper tension of the air in the tympanum. Too great tension of the labyrinthine fluid and consequent injury to the membranous labyrinth are prevented to some extent by the outward bulging of the *membrana tympani secundaria* when the tension is due only to the too forcible incursion of the stapes: the *ducti peri- et endolymphatici* probably relieve any tension in a very short time, and they are also aided by all the lymph-channels about the labyrinth. The too forcible incursion of the stapes is prevented by the tension of the *membrana tympani* itself and by the increased tension of the air in the tympanic cavity as the drum-head goes inward, also by the tension of the ligaments of the ossicula and the action of the *stapedius* muscle. The *membrana tympani secundaria* is prevented by its shape from giving much towards the labyrinth and thus increasing the labyrinthine tension. Too slight tension of the labyrinthine fluid is prevented by the incursion of the stapes, also by the inflow of lymph and blood from the surrounding parts, especially through the membranous aqueducts. The too forcible excursion of the stapes due to the forcible excursion of the drum-head consequent upon the forcing of air into the tympanic cavity is checked by the mechanism of the malleo-incudal articulation, which allows the manubrium of the malleus to make an extended excursion without dragging the long process of the incus with it. The mechanism of the ossicles which allows the incus to slide upward and downward as the manubrium makes an extended oscillation either inward or outward, instead of expending all its force on the head of the stapes, is a protection to the proper tension of the labyrinthine fluid. The distance of the labyrinth from the surface of the head, and the hardness of the petrous bone, are great safeguards against trauma.

Sound-waves reach the inner ear through the bones of the skull, as well as by the usual way through the ossicular chain, the foot-plate of the stapes communicating them to the perilymph. The increase of sound by bone-conduction when the meatus is stopped is probably due both to resonance of the closed cavity and also to the reflection of sound-waves back to the labyrinth which could have escaped through a free meatus. Perhaps the phenomenon is due to the changes in the labyrinth consequent on closing the meatus. Acuteness of hearing diminishes with advancing age. After the fiftieth year sounds which would have been distinctly heard by bone-conduction at an earlier age are unperceived; and as age increases the per-

ception of bone-conducted sounds is lost. A tuning-fork can be heard much longer by air- than by bone-conduction. The sound-waves passing through the air of the tympanum from the *membrana tympani* to the *membrana tympani secundaria* are of little comparative importance; however, Botey¹ thinks that when the stapes is wanting, both the membrane closing the oval window and the *membrana tympani secundaria* serve to transmit sound-vibrations to the perilymph. The sound-waves which reach the labyrinth are transmitted through the fluids in this cavity and impinge on the terminations of the auditory nerve, and the sensation of sound is produced in the brain. The displacement of the labyrinthine fluid is comparatively slight, but is greater for lower than for higher tones. During the positive phase of the sound-wave the stapes is pushed inward and the labyrinthine fluid is compressed, and gives way where it can, chiefly by bulging out the *membrana tympani secundaria*. The functions of the labyrinth are theoretical, but experiments on lower animals make it probable that the *maculae* and *cristae acusticae* of the *sacculi* and *ampullae* can perceive both noise and tone. It is supposed that the *otoliths* serve to damp the vibrations, or, what is more likely, to give a stronger impulse to the cilia than the fluid can give. The *semicircular canals* are not supposed to have any auditory function, but to form the peripheral organ of the sense of space or equilibrium. Flourens and others have shown experimentally that injury to the *semicircular canals* causes motor disturbances. Division of the external canal caused lateral movements of the head, *nystagmus*, and rotation of the body around the long axis. Division of the posterior *semicircular canal* caused regular movements of the head forward and backward, with an inclination to fall backward. After division of the superior canal the animal moves its head forward and backward and tends to fall forward. These symptoms are variously explained by different authors, some of whom suppose them to be due to irritation of a space-organ or an organ of equilibrium contained in the *semicircular canals*, or to the irritation of the canals transmitted reflexly to the *optic thalamus*, while others assert that the symptoms are due to injury of the *cerebellum* consequent upon injury of the *semicircular canals*, or to reflex irritation of the *cerebellum* conveyed through the nerves of the *ampullae*, on the supposition that the *vestibular nerves* are connected with certain parts of the *cerebellum*. This last hypothesis seems to be partly proved by certain experiments which show that irritation of the lateral lobes, or of the posterior part of the lobes and of the *vermis cerebelli superior*, produces symptoms analogous to those which follow on section of the external, posterior, and superior canals. There seems to be some connection between the condition of the inner ear and the movements of the eye, and very probably all co-ordinate movements. Several experimenters agree that the disturbances of co-ordination are due to the irritation and not to the destruction of the *vestibular nerve*. After rotation the eyes

¹ *Annales des Maladies de l'Oreille et du Larynx*, January, 1891.

go through the same motions they made during rotation, only in reverse order: these reactionary symptoms point to the exhaustion of the nervous apparatus which perceives rotation and causes the special movements of the eye. Again, by prolonged rotation the sense of equilibrium is lost, and loss of co-ordination of muscular action follows consequent upon this loss. It might be supposed that a similar irritation of the organ of equilibrium would result in impairment of muscular co-ordination in the eyes; and that this is the fact has been demonstrated clinically. Dr. Spear has reported some cases where there were staggering gait and diplopia consequent upon middle-ear disease, which disappeared on improvement of the condition of the ear.¹

The explanations of the functions of the cochlea are still more hypothetical. The cochlea is supposed to perform a more important rôle in audition than the rest of the labyrinth. The external and internal hair cells of Corti's organ are supposed to be the terminations of the auditory nerve. Corti's rods are not found in birds and reptiles, and consequently are not an essential part of the terminal apparatus.

The basilar membrane is supposed to be the means of communicating the vibrations of the labyrinthine fluid to the hair cells. It is provided with transverse fibres radiating from the lamina spiralis ossea. These fibres are supposed to vibrate to certain notes without a definite boundary between the vibrating fibres and those which remain still. Owing to the shape of the basilar membrane, which is broader above, the lower part containing the shorter fibres serves for the perception of the higher tones. The fibres are set in sympathetic vibration by the motion of the endolymph. The fibres of the basilar membrane vary in length from .041 millimetre at .0262 millimetre from the lower extremity to .495 millimetre at the apex (Hensen). The fibres are estimated at from thirteen thousand to twenty-four thousand. The basal coil vibrates to high tones and the apex coil to low, as is also indicated by pathological cases. As Blake has shown, the upper range of sound-perception is increased after destruction of the membrana tympani, and may reach eighty thousand vibrations per second. The hair cells of Corti's organ are in close relation to the basilar fibres, and are in the proportion of about two fibres to one cell. The inner hair cells are about as one to seven of the cords; the outer hair cells, about as four to seven. One-sixty-fourth of a tone is about the limit of perception of the difference in tone. Preyer says musicians can distinguish with certainty a difference of pitch arising from one-half vibration per second in the doubly accentuated octave. The ear is capable of distinguishing both the pitch, dependent on the number of vibrations, and the quality, due to the form of vibration, as well as the intensity of sound, due to the amplitude of the vibrations. "The ear does not distinguish the different forms of waves in themselves as the eye distinguishes the different vibrational curves.

¹ Philadelphia Medical News, January, 1892.

The ear must be said rather to decompose every wave-form into simple elements according to a definite law. It then receives a sensation from each of these simple elements. The eye is capable of distinguishing every possible different form of vibration one from another, even such as the ear cannot distinguish. But the eye is not capable of resolving the vibrations into simple vibrations, as the ear is. The eye really distinguishes the forms of vibrations as such, and in so doing distinguishes every different form of vibration. The ear, on the other hand, does not distinguish every different form of vibration, but only such as when resolved into pendular vibrations give different consonants. But, on the other hand, by its capability of distinguishing and feeling these very constituents it is again superior to the eye, which is quite incapable of so doing" (Helmholtz). There are about forty inner hair cells for each tone.

There are after-impressions of sound resembling those of sight, but they are not nearly so common nor so lasting, and their cause is not fully explained. The perception of any one continuous tone becomes rapidly lessened, but any fresh tone is heard with unabated force. Auditory centres have been located on the superior temporal convolution of the cerebrum; some of the nerve-fibres are supposed to decussate from one side to the other. The posterior part of the auditory centres is supposed to perceive lower tones, and the anterior higher tones. Destruction of the cortex on the upper surface of the cerebrum has been found not to affect the hearing power.

PART III.

TESTS OF HEARING.

No perfectly satisfactory tests of the hearing power have yet been devised, although a multitude of contrivances have been used. A difficulty which is found in testing the ears separately is that it is next to impossible to exclude the hearing from the other ear: this, however, is usually of no great practical importance. In testing it should be remembered that the intensity of sound in space decreases inversely as the square of the distance from the sounding body. As disease usually affects the perception of different kinds of sounds differently, it is desirable to use tests which will discover any alteration in the power of the perception for various sounds. These tests are the human voice, tuning-forks for musical sounds, the watch for a noisy sound, König's rods or Galton's whistle for testing the upper limit of perception, and various electrical appliances. With all tests it is well to have the eyes of the patient turned away or closed. The ear should be tested by both air- and bone-conduction. The comparison of the results of these two methods is supposed to throw a little light on the presence of conductive or perceptive disturbances. When by air-conduction the sound is heard louder than by bone-conduction the condition is either normal or

the seat of the trouble may be first suspected in the perceptive apparatus: if, on the contrary, the sound is better heard by bone-conduction we may first suspect derangement in the conducting apparatus or closure of the external meatus. Bone-conduction conveys sound-waves directly to the labyrinth and to a lesser degree to the membrana tympani, and thus through the ossicula to the labyrinth. In testing bone-conduction the sounding body is applied to the mastoid process, zygoma, or some other superficial bone on the side of the head (note which bone is used), when that ear alone is to be tested; or to the vertex, forehead, etc., in the mesial plane when the two ears are to be comparatively tested. Placing the sounding body between the teeth gives the most intense sound-impression; the perception is also increased by closing the meatus with the fingers. The sound is heard actually increased above normal or relatively louder in the ear having defective conductive apparatus or closed meatus. The ear having defective perceptive apparatus perceives the sound actually diminished below normal or relatively weak. It sometimes happens that the watch and tuning-fork give diametrically opposite results, the tuning-fork being heard louder in the diseased ear, but the watch louder in the normal ear. This has been explained on the theory that with the greater volume of sound of the tuning-fork more is reflected back to the labyrinth by a diseased conductive apparatus, whereas with the weaker sound of the watch little is reflected back to a somewhat diseased labyrinth, and in consequence the labyrinth is not stimulated as much as the other side which is more normal in both perceptive and conductive apparatus. In testing by air-conduction for one ear the sounding body should be held in the sagittal plane of the head on the side to be tested and the ear on the opposite side closed as tightly as possible; usually the finger of the patient is sufficient. For testing both ears simultaneously, the sounding body should be held in the mesial plane, preferably at the back of the head, to prevent the patient's seeing it. In testing the hearing distance, except for the voice, the sounding body is to be moved from beyond the hearing distance towards the patient and away again out of the hearing distance several times in order to give approximate accuracy, the patient having been instructed to say when the sound is perceived and when it is lost.

The hearing distance is usually expressed by fractions, the numerator denoting the distance at which the sounding body is heard and the denominator the distance at which the sounding body can be heard by the normal ear. Abbreviations are employed to express the kind of sounding body used, and also whether by air- or bone-conduction, and if by bone-conduction, by what bone. It is well to note also any peculiarities in the character of the sound-impression, whether in quality, time, location, or duration. When there exists a great difference in the hearing power of the two ears and the feebler one is being tested, it requires great care that the sound heard in the better ear should not be referred to the other one. When tests are applied in different rooms or under different outside conditions of noise or anything

which might attract the patient's attention, it should be borne in mind that the hearing capacity may be considerably altered. The hearing capacity also varies considerably in the normal individual at different times even on the same day.

The *watch* is the most convenient of all tests, and can be used by both bone- and air-conduction. The normal distance of hearing must be determined individually for every watch; also the watch should always be held in the same relative position to the patient,—that is, having the same surface always directed to the patient. The watch gives a test for sounds intermediate between a noise and a musical note.

Politzer's *acoumeter* is of a convenient size to carry in the pocket, and can be used in place of a watch. The tests made by an *acoumeter* are readily compared with others if the instrument is properly made, because of the constant intensity of its sound. The *acoumeter* gives a musical sound. The chief difficulty in the use of the *acoumeter* is that the normal hearing-distance for it is too great for convenience. In consequence of its loud sound the *acoumeter* is of great service in testing cases with greatly-impaired hearing. The *acoumeter* can be used for testing both air- and bone-conduction.

The *tuning-fork* is the most convenient method of testing musical tones, and can be used for air- or bone-conduction. In testing air-conduction it is to be borne in mind that there is interference of sound-waves opposite each angle of the tuning-fork, which may prevent the patient from hearing the fork when the angle is turned towards him, whereas in other positions he might hear it perfectly. The tuning-fork is heard loudest if the vibrating end of one of the external surfaces of the prongs is held directly at the meatus.

A fork of five hundred and twelve vibrations a second has the most convenient pitch if one fork only is to be used. It is best, however, to use a series of forks both low and high, from C up to C'''. A series of as many as twenty forks is used to advantage by some observers. The greatest objection to the use of a tuning-fork is the presence of over-tones, which the patient may hear when he is unable to hear the fundamental, and thus mislead the experimenter. To avoid the over-tones a number of devices have been tried. The ends of the prongs of the tuning-fork can be weighted by metal clamps; this lowers the pitch of the fork. By moving the clamp down the pitch is raised, so this device not only lessens the over-tones, but also allows the fork to be used for testing several different tones. The ends of the prongs of the fork can be made heavier, as in Blake's forks, their weight serving to damp the over-tones. To avoid the over-tones precautions must be taken also in sounding the tuning-fork: it should be struck sharply on something soft, as a piece of soft wood or vulcanized rubber, or the over-tones will be predominant. The over-tones can be damped by grasping the prongs in the hand near their bases. To give a constant initial intensity to the sounding-fork it should be sounded always in the same manner by striking an end of one of the external surfaces of

the prongs with the same force on a substance of the same hardness. Blake's fork, which has the tips of the prongs enlarged on their external sides by the addition of a triangular piece of metal with its base at the end of the prong, has two advantages; one that the over-tones are lessened by the extra weight of the tips of the prongs, and the other that the fork can be sounded with a constant initial intensity by drawing it between the thumb and fingers, thus pinching the prongs together and setting them free the moment the fingers glide past the triangular enlargement of the prongs. For the purpose of using a fork vibrating with a constant intensity, electrical stimulation is used. To increase the intensity of the tuning-fork for use with very deaf people a resonator can be used. To compare the perception by air-conduction of the two ears an auscultation tube can be placed in each ear and the free ends brought alternately near the vibrating fork. To determine more accurately the hearing capacity a T-shaped auscultation tube can be used; one end of the horizontal limb is inserted in the patient's ear and the other end in the experimenter's ear; the free end of the vertical limb is brought close to the vibrating fork, and the difference between the length of time the sound continues to be perceived by the patient and by the experimenter is taken as a measure of the deficiency in the hearing power of the patient.

Politzer advises closing the ears with the opposite ends of an auscultation tube during the test by bone-conduction, in order to exclude all sound by air-conduction.

The tests by the tuning-fork are useful in determining derangements of tension in the auditory apparatus, these derangements causing the patient to misjudge the pitch of the fork one-fourth to one tone higher or lower than it really is.

Gellé suggests the use of the tuning-fork on the vertex, the experimenter at the same time using the auscultation tube, during swallowing, yawning, and voluntary contraction of the tympanic muscles, or anything which mobilizes the auditory apparatus. By this means the condition of the Eustachian tube and the accommodative power of the tympanic muscles and also the condition of the *membrana tympani* can be tested with the aid of the subjective hearing of the patient, bearing in mind that whatever makes the *membrana tympani* tense and rigid tends to impede the passage of sound from the tympanum into the auscultation tube.¹

Blake's modification of König's rods is useful in determining the perception of high tones; they are steel cylinders twenty millimetres in diameter, suspended at two points one-fifth of the length of the rod from each end and struck by a metal hammer. The rods are of the required length to form a series with intervals of five thousand vibrations from twenty thousand to one hundred thousand per second.

In testing with the rods it is necessary for the patient to distinguish

¹ *Annales des Maladies de l'Oreille, etc.*, 1890.

between the sound of the blow of the hammer and the vibration of the rod.

Galton's whistle is a convenient way of testing roughly the perception of high tones. The pitch of the whistle can be changed by a screw.

The *human voice as a test of hearing* is probably the most important of all, for it is the sound more than all others that a deaf person desires to hear. Unfortunately, there are many obstacles to its use, especially as regards accuracy. The experimenter has to learn through practice what is the normal hearing-distance for words spoken with a given intensity, and must learn this for several distances. It is well to become accustomed to using the voice at a given intensity, pitch, and distinctness, such that the normal limit of hearing will be a convenient distance for testing in a room. It should also be borne in mind that a change in surrounding conditions or of the room makes more difference in voice-tests than in any other, and that the tests have to be learned separately for every change of conditions; also daily changes in the experimenter's voice have to be allowed for.

Lucas's "maximal phonometer" is intended to register the intensity of any spoken word. It consists of a tube with a membrane drawn across one end, to this membrane a lever being attached which registers the amplitude of its movements when a word is spoken into the open end of the tube.

In testing extremely deaf persons, the only result that can usually be reached is whether or not they can hear the voice at all, even when used with the utmost force. Often the sound can be heard but the sense is not appreciated. When the patient cannot hear the unaided voice, an ear-trumpet should be used. The patient may hear better with this, but sometimes the reverse is the case.

In testing with speech, whispering, ordinary conversation, and loud voice are to be used. This is their order of importance. Whispered words give usually the most accurate results. In whispered voice the vowel sounds are weakened, but the consonants are less changed. Vowel sounds approach more nearly than consonants to simple musical sounds, and consequently the vowels are more easily heard than the consonants. Of the vowels, *a*, *e*, and *i* are more easily heard than *o* and *u*.

Blake classifies the consonants according to their characteristic intensity or "logographic value." He puts *t* first and *m* last, with the relative proportion of 100 to 9. The order is:

T	100	S	40
Z	63	F	35
C	62	K	31
P	58	L	21
G	56	N	11
B	53	M	9
D	45		

H is the letter having the least intensity of sound.

Whispered speech and consonant sounds are best adapted for testing, because they are more difficult to hear, and give more accurate results on account of their even intensity. Monosyllables are preferable for this purpose, for the same reason. Some words are heard at greater distance than others; this depends chiefly on the familiarity of the patient with the word, but also on the individual intensity of the letters of the word. Words of a foreign language are heard only at about one-fifth the distance of the accustomed words. The cadence of the syllables and arrangement of the vowels and consonants undoubtedly affect the ease of perception. Sentences are often heard when single words are not; this is probably due to the patient's hearing some of the sounds and supplying the deficiencies himself. It is best to begin the test with single words, beginning with those difficult of appreciation, and gradually trying easier words, short sentences, or questions, till the patient can repeat what the operator says, if he can hear at all.

Both ears should be tested together, and each separately, whether or not they have been tested by other methods before. The hearing for the voice is usually more impaired than for simpler sounds, though the reverse is sometimes the case.

Wolf advises using the self-sounding consonants as tests of hearing rather than tuning-forks, taking the German consonants *s*, *sch*, and *g* (soft) for the acute sounds; *b*, *k*, and *t* for medium pitch; and *r* rolling, and whispered *u*, for low pitch. The *r* sound is rather a test for the defect of the perceptive apparatus.¹

In testing both ears the experimenter will find it convenient to stand behind the patient, and when testing one ear to stand at the side, care being taken to cover the patient's eyes and also to stop the opposite ear. When one ear is much more affected than the other the utmost precautions may not suffice to prevent the patient's hearing a little with the better ear. The accuracy of the test can be partially proved by having the patient close both ears, when if the patient still hears as well as when the good ear only was closed, it proves that the hearing is due to the good ear, but if the patient hears nothing with both ears closed it indicates that the test applied only to the ear that before was not stopped.

It is best to use single words, but short sentences constantly varied to prevent the patient from guessing correctly are often the more convenient tests. It is well also to use both whispered and spoken words. The patient should repeat what he has heard, or what he thinks he has heard, after the experimenter.

Of course voice-tests are valueless if the experimenter's face is seen by the patient, owing to the facility which most deaf persons have in understanding the motions of the lips.

Testing by pronouncing the single figures is apt to lead to inaccuracy,

¹ Archives of Otology, 1890.

because the patient soon learns to guess the right one, as their number is so limited.

The same word should not be used more than once with the same patient, if possible, for this reason. It is always necessary to guard against the patient's guessing the meaning without hearing perfectly,—a trick which most deaf people are expert at. In testing children, tests other than the voice are of little good. Care should be taken to use words familiar to the child, and not too many of them.

Electrical Tests of Hearing.—The objections to the use of electricity in testing are the bulkiness of the apparatus, the amount of care required to keep it in running order, and, lastly, the expense.

The telephone has been variously adapted for use as an absolute test of hearing. It can be used with the human voice or any other source of sound. Various devices are utilized in the circuit to give a definite resistance, of which a rheostat is the best. A double telephone can be used, which gives the experimenter the advantage of being able to prevent deception on the patient's part by testing the ears alternately, if necessary, without the patient's being forewarned as to which ear is being tested.

The phonograph affords many of the desiderata for a test of hearing, with but two objections,—viz., size and expense. It can give all sounds, including the human voice. It gives a constant sound, as it can be applied directly to the ear by means of a double telephone. Outside conditions have but little effect, and either ear or both together can be tested. The cylinders can be kept and the test repeated; also a series of cylinders can be accurately made and used in testing. Thus an absolute test is made which can be multiplied and repeated indefinitely.

Cheval describes an electro-acoumeter with a double telephone, tuning-fork, and microphone. If combined with a phonograph this would give an absolute test for hearing if the current were kept constant by a rheostat or some other means.¹

Rinne's method of testing hearing depends on the fact that normally air-conduction is better than bone-conduction. The vibrating tuning-fork is placed against the incisor teeth, and when the patient ceases to hear it the fork is placed opposite to the meatus; then if the sound is again heard it is called a positive test, "+R," but if the sound is not heard by air-conduction after it has ceased being heard by bone-conduction, the result is called "—R."

Weber's method depends on the fact that by bone-conduction a sound is heard louder when the meatus is closed. A vibrating tuning-fork is placed upon the skull, and it is noted whether it is heard more or less loud when the meatus is stopped up or when it is free.

After all, the voice and the watch are the tests one usually falls back upon.

¹ Revue de Laryngologie, etc., 1891.

EXAMINATION OF PATIENTS; WITH INSTRUMENTS NEEDED THEREIN, AND METHODS OF THEIR EMPLOYMENT.

BY HUNTINGTON RICHARDS, M.D.,

Des Moines, Iowa,

Formerly Aural Surgeon at the New York Eye and Ear Infirmary; and formerly Chief
of Clinic in Aural Department of the College of Physicians and Surgeons,
New York City.

ACCURACY of diagnosis being in pre-eminent degree a necessary preliminary to right treatment in otological practice, it shall be the object of this paper to set forth briefly and so far as may be done in written words methods of examining patients which should conduce to the attainment of a due measure of such accuracy.

The examination of a patient suffering from any form of aural disease is twofold,—that is, it may be subdivided into two steps or two processes,—viz., (*a*) an inquiry into the history and symptoms of the disease, and (*b*) a physical examination of both ears and of their function by means of properly-constructed and skilfully and judiciously used instruments. Of these two steps or processes the former is always of value, is often of great value, is never to be omitted, is generally to be first adopted; the latter is almost always indispensable to accurate diagnosis. In following the latter step or process, there will of necessity be demanded a certain degree of further inquiry into the symptoms and sensations of the patient, and this will be especially true of that part of the physical and instrumental examination directed to measurement of the degree of functional activity possessed by the ears; yet the leading features presented by any case of aural disease as to its symptomatology, the order of sequence of symptoms, and the duration and special intensity or value of each separate symptom, should in every instance be ascertained, as far as possible, before proceeding to the physical examination.

In accordance with the rule just laid down, this paper will be divided into two sections, of which the first will briefly discuss the important subject of the preliminary taking of the clinical history, or anamnesis ("calling

to mind”), of the patient; while the second will attempt to describe more extendedly and thoroughly the essential process of a properly-conducted physical examination.

A. THE CLINICAL HISTORY, OR ANAMNESIS.

The physician, having recorded the patient's name and age (or approximate age), together with such facts regarding residence and occupation as he may for any cause see fit to inquire into, should make it his rule throughout this portion of the examination to sit with note-book and pencil in hand and to set down in writing all the leading facts as to the presence, the degree or value, the duration, and the order of sequence of such symptoms as shall be reported to him either by the patient or, in the case of a young child or a deaf-mute, by the parents or friends of the patient. He should also note the absence of symptoms not so specified or whose existence is denied. As in all departments of practice, he should, in obtaining and recording this previous clinical history, allow the patient (or the accompanying parents or friends) to do most of the talking; and for reasons holding good in all departments of practice, and pre-eminently so in otological practice, during this first and purely narrative stage of the examination he should abstain in the main from putting questions likely to suggest symptoms not noticed by or complained of by the patient himself, such questions being liable to distort the patient's own view of the relative severity and value of the various symptoms observed by himself. This rule is of particular application to cases of suspected chronic catarrhal otitis media, where, not only for the guidance of the physician, but also and much more for the present and future comfort of the patient, it is of importance that the examiner should not, by the nature or manner of his inquiries, suggest to the mind of the sufferer subjective sensations (such as pain and tinnitus) liable to exaggeration in the reporting, and likely thereafter to be more acutely and distressingly felt by the patient from the fact of his attention having been specially called to them. Particularly is this true as regards the annoying symptom of tinnitus when either reported in or suspected in a case of chronic otitis, whether catarrhal or suppurative. The symptom, if subjectively prominent at the time of examination, will very certainly be mentioned by the patient himself; if not present in marked degree, its existence may be sufficiently ascertained either by an assumedly “hap-hazard” and non-emphatic method of inquiry: in some cases its absence may safely and properly be inferred from the silence of the patient thereupon. Let the physician always remember that it is his duty to his patient rather than to himself or to his profession that demands an accurate diagnosis, and that the chief justifying object of such diagnosis is ultimate benefit to the patient examined, and let him beware, in the class of chronic cases just specified, lest by *unnecessarily* exhaustive inquiry he be the suggestor and the causer to his patient of an ultimate increase of suffering, perhaps in part imaginary, but none the less real.

The chief symptoms to be ascertained by the narrative and inquisitorial examination are those of deafness, pain, tinnitus, autophony, sensation of obstruction or stuffiness in the ears; in the severer cases, those of vertigo, headache, disturbances of gait or of vision, and facial or other paralysis; also those of aural discharge and itching in the ears. Discussion of the respective diagnostic import and value of these symptoms does not, of course, belong to the subject-matter of this paper, save in so far as the ascertaining of each must, of necessity, guide the examining physician in his further inquiries and in the choice of methods to be adopted in the physical and instrumental examination of the ears. As a guide to the choice of instrumental methods it is important, it is sometimes essential; for the use of certain methods and instruments of diagnosis is often forbidden by the previously-ascertained presence of some one or more of the symptoms just specified. This fact will be made apparent when we come to detailed discussion of these methods and instruments.

Some progress towards the attainment of accurate diagnosis in any case of aural disease can be made by careful consideration of the symptoms reported; but every one who has had much experience in otological practice will corroborate the truth of a deliberate statement made elsewhere by the writer, that for the attainment of truly accurate diagnosis, save in the case of disease or lesion limited to the auricle, an examination of the ears by means of proper instruments may invariably be deemed essential.

B. THE PHYSICAL EXAMINATION.

Setting aside, as superfluous to the strict subject-matter of this paper and as elsewhere sufficiently discussed, the cases of disease confined exclusively to the auricle and not involving the auditory canal or deeper portions of the ear, and passing over any consideration of such symptoms as tumefaction, congestion, and tenderness to pressure of the integuments lying before, behind, above, or below the ear,—symptoms, indeed, of great importance, but of a nature easily determinable by unaided ocular inspection and by gentle palpation,—it is proposed in this the chief section of the present paper to discuss those methods of examination necessary to form a diagnosis of disease affecting the auditory canal, the tympanum, and the annexes of the latter, to wit, the Eustachian canal and the pneumatic spaces of the mastoid process and of other portions of the temporal bone which are contiguous to and communicate with the tympanum. Disease either primary or secondary of the internal ear and the methods for its detection are sufficiently discussed in other articles of this book.

Whether or not deafness be complained of, a careful testing of the hearing-power of both ears should be made in the case of every patient applying for relief from any form of aural disease. This testing should precede all other steps in physical examination, and its result should be noted as soon as ascertained. The proper methods of testing the hearing are discussed in another paper.

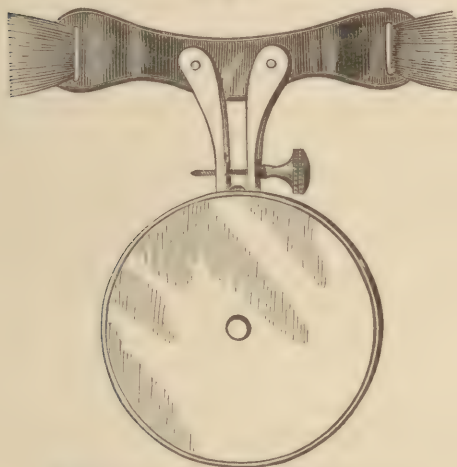
The first essential to right examination of the auditory canal and tympanum is properly-constructed and properly-used apparatus for throwing reflected light into the ear. This reflected light may be sunlight, diffused daylight, or artificial light. The two former possess the slight advantage over ordinary artificial light of showing the natural color of the parts seen. Electric light will do the same in good degree. Sunlight is not always to be had, diffused daylight varies greatly in intensity, electric light is expensive and is unnecessarily brilliant for ordinary work, though useful in a certain class of surgical operations. It is desirable that the physician should accustom himself to the use of a form of light always readily obtainable, suitable to work either by day or by night, and approximately constant in color as well as in intensity. Such a light will be given by any good kerosene lamp or by an Argand gas-burner. In emergency and when called to visit a patient at his home, the examiner habituated to the use of this kerosene or gas light will find himself capable of succeeding fairly well even if obliged to use common candle-light. I know of no better form of burner for office use than that which consists of an Argand drop light carried at the extremity of a horizontal bar or arm which slides vertically upon an upright fastened to a heavily-loaded base of support. By a screw the horizontal bar can be fixed at any required height above the examining table; the base of the upright bar being heavily loaded, there is no risk of capsizing; and movement of the lamp in a lateral direction will be limited only by the length of the flexible tubing which connects the gas-fixture with that end of the horizontal sliding bar which is opposite to the one carrying the Argand burner. Condensation of the light by "bull's-eye" chimney is unnecessary in ear work, however desirable it may be for nasal and laryngeal examinations, and the use of such a condensing apparatus will lead to the waste of much time expended upon shifting the burner into a precisely accurate position.

The light must be reflected into the patient's ear. For this purpose the examiner should use a concave mirror. This mirror he should wear upon his head, thus leaving both hands free. A good type of such a mirror is shown in the accompanying illustrations (Figs. 1 and 2), which show respectively a front and a side view of the mirror adopted and used by Dr. Albert H. Buck, of New York City, and described in detail in his work entitled "A Manual of Diseases of the Ear." I know no better form of head-mirror for aural work, and as a well-constructed mirror is of great importance to ease and accuracy of examination, and such a well-constructed mirror is not always to be had ready made at the shops, I shall here transcribe a part of the description given in the work just mentioned. The forehead-plate of this mirror is made of hard rubber, is nine and a half centimetres long, two and a half centimetres wide at its broadest part, is a little more than a millimetre thick, is "curved flatwise so as to lie at all points in firm contact with the forehead," and, for the easier preservation of cleanliness and the insuring of a greater degree of stability when ad-

justed, is designedly left unpadded. The ends of the head-straps for a distance of five inches from their insertion into the forehead-plates are preferably to be made of undyed leather. "Beyond these limits an elastic or non-elastic material of any color may be used. The adjustment of the band to the size of the head is effected by means of a buckle."¹

As is well observed by the author just quoted, the method of attachment to be followed in securing the mirror to its head-band is by no means a matter of indifference. On this method depends the degree of mobility that will be preserved by the mirror, and the greater its range of mobility the greater the independence of the observer as regards the precise direction from which the direct light of the lamp or gas-burner will fall upon the mirror. Mobility and stability in position are both to be desired. To secure a high degree of the former, the slender brass stem ending in a brass ball (shown in Fig. 2) "should be fastened to the mirror at a distance

FIG. 1.



Forehead-mirror. (Half the natural size.)

FIG. 2.



Forehead-mirror, profile view.

not exceeding seven millimetres (or about one-fourth of an inch) from its circumference." The stem should be about seven millimetres long; the brass ball should measure one centimetre in diameter. It is grasped by the lower ends of two slender forceps-like shanks, each of which should be fastened by a single rivet to the hard-rubber forehead-plate, and each of which is hollowed out at its lower end into a shallow cup-shaped concavity, to insure by this means a sort of ball-and-socket articulation. A screw, shown in the illustrations, passes through a slot in one of the shanks and through a hole in the other, and serves to tighten the grasp of these forceps-like supports upon the ball, thus securing stability of the mirror while permitting free mobility.

¹ A Manual of Diseases of the Ear, by Albert H. Buck, M.D., William Wood & Co., New York, 1889.

The mirror itself should be of light construction, being not more than two and a half millimetres thick, should measure about seven and a half centimetres in diameter, and should have a focal distance of from five to twelve inches. It is well that it should be perforated at its centre, having at this point an unglazed aperture measuring seven and a half millimetres in diameter. Mirrors of long focal distance are most suitable to the use of far-sighted observers. In the case of such the mirror may be lowered so as to be carried in front of the point of the observer's nose, allowing him to look over its upper border. When so worn the central aperture may be dispensed with. More commonly it is worn directly in front of one or the other of the observer's eyes, in which case the central aperture will be, of course, indispensable. The writer, being somewhat near-sighted, invariably wears the perforated mirror in the manner just described, and finds an instrument having a focal length of about seven inches most suited to his needs.

As to the relative positions of light, patient, and examiner, let the latter sit directly facing the ear to be examined, placing the light about on a level with his eye and the patient's ear and a little to one side of and beyond the patient's head. If he use his right eye, let the light stand to the right; if his left eye, to the left. These relative positions are to be maintained throughout the examination and should be carefully adjusted before it is begun. To see the light the examiner should need to turn his eyes only and never his head. (Buck, *op. cit.*) The light, the patient's head, and his own head, wearing the mirror properly adjusted, being thus relatively placed, let the examiner by rotation of the mirror alone catch the light upon it and throw the reflected light into the patient's ear; and thenceforward throughout the examination let all shifting of the light be thus accomplished,—viz., by rotation of the mirror, not by motion of the examiner's head. If the physician be tempted to move his head he has good evidence that the position of his source of light requires to be changed.

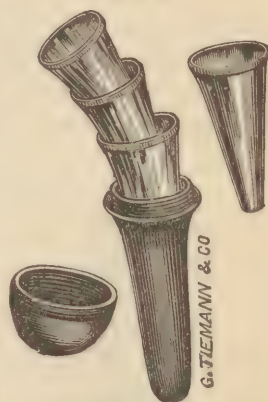
In rare instances when reflected light has been properly thrown upon the opening of the auditory canal, the observer will obtain at once a fairly good view of the membrana tympani and the deep-lying portion of the canal walls. Almost invariably, however, a good view of either canal walls or membrana will be attainable only by artificial straightening of the tortuosities of the canal. Such straightening is in some degree securable by gentle traction upon the auricle. In the case of an adult, traction should be exerted in a direction backward, outward, and a little upward; in the case of a young child, traction should be directly outward and rather downward than upward. Further straightening of the canal and dilatation of its outer or cartilaginous portion—its only dilatable portion—will call for the use of some form of aural speculum. Of such specula there are many varieties. Without the speculum otological practice is impossible; a really well-made speculum is the most essential part of the aural surgeon's armamentarium. It is in this country but rarely to be found ready made at the

shops, and the chief fault of the instruments offered for sale consists in a decidedly too great thickness of wall. I would, therefore, advise all my readers to insist upon having their specula made to order, and for their guidance in so doing shall presently give the accurate dimensions of a good set of one of the leading and most-used types of speculum, that first introduced by Dr. William R. Wilde, of Dublin.

Figure 3 shows approximately the right shape of these instruments. This illustration, including the five groups of numbers which accompany it, is taken from an article prepared by myself for the "Reference Hand-Book of the Medical Sciences."¹ As commonly sold, a set of Wilde's specula comprises but four instruments; it should preferably comprise five. They should be made of coin silver, not of German silver. Under A I give the dimensions as to length, width of wider and width of smaller end of the largest one of such a set of five specula; under E, the corresponding measurements of the smallest instrument; B, C, and D give the measures for the intervening sizes. The upper figure of each group of three is the measure of length, the next, that of width at larger, the lowest, that of width at smaller end. *All are inside measurements*, and the unit of measurement adopted is the millimetre ($= 0.039371$ inch).

In thickness the wall of the speculum should but slightly exceed one-tenth of a millimetre. As a further guide to accuracy in construction, I would here mention that the exact weight of an old set of such specula in my possession is two hundred and twenty grains (apothecaries' measure), and that of a nearly new set comprising the unnecessary number of eight instruments is three hundred and eighty grains. Ready-made specula are often too short and often too "stumpy." Right length and right slope of walls are both important. If the physician will insist upon precise compliance with the measurements given under Fig. 3, his instrument-maker will give him a properly-shaped set of specula; if he will insist upon the equally important matter of great thinness of wall, he will rightly and easily diagnosticate many a case of aural disease much less readily diagnosed through the thick-walled and badly-proportioned specula commonly exposed for sale. The notching of the border at the wider end of the speculum is an important feature, as it steadies the grasp of the fingers when introducing the instrument.

FIG. 3.



Wilde's specula.

A	B	C	D	E
34.5	35.0	35.5	35.5	35.5
12.66	15.0	14.5	14.0	13.5
7.0	6.0	4.66	4.0	3.5

¹ "Examination of the Ear for Purposes of Diagnosis," in vol. ii. of "A Reference Hand-Book of the Medical Sciences," William Wood & Co., New York.

In Figs. 4 and 5 are shown two other commonly-employed types of speculum; that shown in Fig. 4 is the metal speculum of Prof. Josef Gruber, of Vienna; a good instrument, but objectionable, in the writer's opinion, on account of the oval outline of its cross-section. Prof. Gruber adopted this feature of his speculum as tending to make it correspond better to the form of the auditory canal, but it hinders the easy introduction of the instrument, which by reason of possessing it cannot be rotated during introduction. In Fig. 5 is shown the hard-rubber speculum of Prof. Adam Politzer, of Vienna. This instrument is well adapted for use in the case of very young children, and is serviceable in a case where there is either great swelling of the canal wall or very marked tenderness of this wall. For operative procedures the Wilde type of speculum is much to be preferred to either of these latter two. The inner wall of all



metal specula should be highly polished (not blackened, as is sometimes the case).

Another good and serviceable type of ear-speculum is shown in Fig. 6, which was kindly sent me by Dr. Gorham Bacon, of New York City, and which shows the dimensions as well as the form of the instrument. It is known as Boucheron's speculum. A set of such specula comprises three instruments. Of these the largest has a diameter of thirty-three and a half millimetres at its mouth, while the two smaller ones have each a diameter at its wider end of thirty-one and a half millimetres. The diameters of the narrower ends are respectively as follows: six, five and a half, and five millimetres. The instruments are made of polished silver. At the New York Eye and Ear Infirmary last summer (1891) I made trial of the set of these instruments which Dr. Bacon had just brought with him from Europe, and was both surprised at and pleased with their efficiency. Dr. Bacon writes me, under date of March 12, 1892, "I like the specula very much and use them constantly." For operative use I can hardly believe them equal to the Wilde specula, though my own test of last summer was but brief and confined to their use as a means of inspection.

In introducing an aural speculum let the entrance of the auditory canal

be first properly illuminated, and the auricle properly retracted. Let the examiner hold the speculum throughout its introduction so that its long axis shall remain parallel with the axis of the canal, and avoid rotation of the instrument about its short axis,—that is, abstain from “wiggling it around” in the ear. Slight rotation of the speculum about its long axis will facilitate its insertion. The inner end of the instrument must be kept continually in view and well lighted, and introduction should cease as soon as a good view of the drum-membrane has been attained. The wider the speculum the more extended will be the view of all the deeper-lying parts, the brighter their illumination, and the less the risk of irritation of the wall of the osseous portion of the canal from shifting or too deep introduction of the instrument. But forcible insertion of any speculum, either large or small, is always carefully to be avoided, and when tenderness before or behind the ear is present, or gentle traction of the auricle causes pain to the patient, or when the canal entrance is stenosed, the smaller sizes of speculum are generally first to be tried. To avoid risk of impaction against a furuncle or a foreign body lying within the canal, examination under good light by traction alone should precede recourse to any variety or size of speculum.

Simple stenosis of the canal may sometimes be overcome by exceedingly slow, cautious introduction of well-greased specula of various sizes, beginning with the smallest, and also by the use of firm cotton pledgets wound tightly about the end of a probe or cotton-carrier, moulded into the shape of a bougie à boule, and abundantly lubricated with vaseline. In using these methods let the physician treat the stenosed canal as he would treat a strictured urethra. Dilatation by laminaria tents is very rarely necessary, and by no means rarely dangerous. The inexperienced aurist should not even entertain the thought of resort to such a process. On the occasion of a first examination especially, the physician should carefully observe all successive points of the auditory canal during both introduction and withdrawal of the speculum. It is rarely that proper introduction of a speculum need cause any degree of pain to the patient. Be it always remembered that the speculum is a foreign body in the auditory canal, and that its protracted presence therein is always more or less detrimental not only to the canal walls, but also, by reason of its pressure upon blood-vessels, to the deeper-lying structures of the ear.

To obtain a good view of the drum-membrane and of the contiguous portion of the canal walls the ear must be clean,—that is, freed so far as possible from any foreign bodies, from accumulations of wax, of exfoliated epithelium, of purulent or other pathological excretions, and finally, when douching has been employed as a means of so freeing it, must be also freed from any remains of the water used in douching. The more perfect the preliminary cleansing of the ear the better will be the view and the more accurate the diagnosis. The removal of solid bodies acting as obstacles to good vision of these parts and the use of instrumental means towards such

removal are discussed in another paper of this series; yet the reader may reasonably look for brief discussion in this article of the methods and instruments commonly needed for removal of such hinderances to view as are apt to be met with in simple examination. These instruments are the syringe, the slender cotton-holder, the blunt curette, the blunt hook, and the slender angular forceps.

Practical experience and common sense are together the only safe guides to either choice or use of these or other like instruments. The syringe is especially adapted to the removal of large solid obstructing bodies, but has its use also in removing smaller bodies of this class. Absorbent cotton securely twisted about the end of the always slender cotton-carrier is useful

for the clearing away of small accumulations of fluid, but where much fluid is present, and especially if this fluid be of a stringy, muco-purulent character, a primary syringing will commonly be found requisite to its speedy and thorough removal. For freeing the tympanic cavity of fluid in cases wherein a perforation of the membrana tympani exists, absorbent cotton is essential, and is best employed in the form of slender wicks projecting some distance beyond the end of the cotton-carrier. These wicks may be bent so as to reach up into the fornix tympani, towards the antrum, and into the tympanal mouth of the Eustachian tube. Dr. Blake of Boston uses similar wicks very tightly rolled and bent sharply at an angle as examining probes for the cavum tympani. Where small, deeply-concave, and highly-reflecting surfaces are observed in examining a distorted or cicatricial drum-membrane, a small pledget or slender wick of absorbent cotton is not seldom of use in determining the presence or absence of moisture as possible cause of the observed reflection; and probe-like cotton wicks, from their absorptive action upon intra-tympanal pus or mucus, will frequently serve to cause sharp demarcation of the margin of a "pin-hole" perforation in the membrana flaccida or membrana vibrans.

The blunt curette shown in Fig. 7 may be considered as an ear-spade. Of this instrument it is well for the examiner to have two sizes, and of the two the smaller will be found the more useful. The diameter of the ring in the smaller instrument should be two millimetres, and it is well to have the instrument made of pure silver, rather than of coin or sterling silver, thus insuring a maximum degree of pliability close to the ring. The larger-sized curette may be made of coin silver, German silver, or

steel. The blunt curette is useful for so shifting the position of skin flakes and other small or flat bodies lying against the canal wall as better to

Fig. 7.



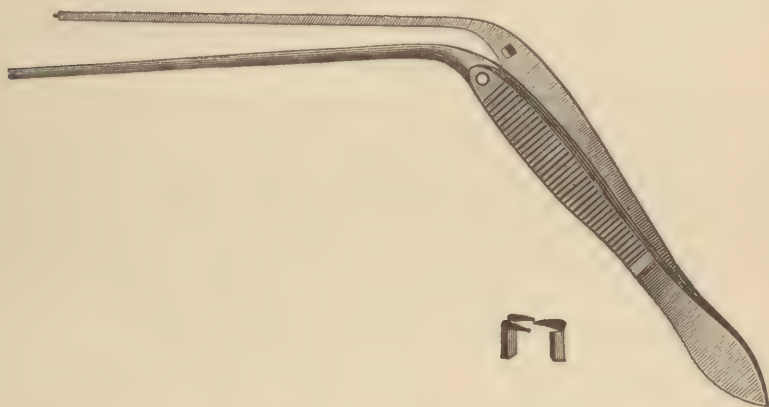
Blunt curettes.

facilitate a grasping of them by the slender forceps (Fig. 8) or else to place them in better position for impact by the return current from the syringe. Its proper use calls for delicacy of touch, that irritation of the membrane or canal wall may be avoided. The sharp curette, occasionally of use in practice, is never needed in examination.

The blunt hook is not shown by illustration. It should be of slender make, about as long as the curette; its hook-end should be short (not more than two millimetres long), not more than one-fifth of a millimetre thick, and not curved, but straight and running out at right angles to the staff of the instrument.¹ The blunt hook may be regarded as the ear-rake. Detailed discussion of its use belongs to the article treating of foreign bodies.

The angular forceps shown in Fig. 8 should be of slender make. The illustration shows them fairly well, but the blades should be little if at all

FIG. 8.



Angular forceps.

more than half as wide as there depicted, and would be better if made from one-half to three-quarters of an inch longer. The top of the blades may interlock, as there shown, by the so-called "rat-tooth" mortise, or else the blades may be notched on the inner surface for a distance of half an inch back from their ends, constituting the "mouse-tail" variety. Both styles are useful, but the "mouse-tail" tip is generally preferable to the "rat-tooth" type.

The forceps, the curette, the syringe, the cotton-carrier, and the blunt hook are instruments of extraction for use preparatory to diagnosis. The instrument next to be described—viz., the slender probe (Fig. 9)—is, like the mirror, the speculum, and the cotton-carrier when used as a probe, a true diagnostic instrument. The probe, at least throughout its slenderer portion, should be made of silver, and, as in the case of the curette, it is

¹ For removing plugs of cerumen a small sharp-pointed hook is sometimes useful, but it is a dangerous instrument in any but very experienced hands.

desirable that the examiner should possess one such instrument made of absolutely pure or "virgin" silver. The handle of the probe should be four-sided, thus permitting the grasp upon it of the examiner's fingers to be both steady and delicate. The due proportions as well as the right size of the instrument are shown in the illustration. The slender ear-probe is the examiner's tactile finger, and memory of this fact will sufficiently define its uses and its method of use.

Fig. 9.



Probe.

Another distinctively diagnostic instrument, although an instrument but rarely used in common practice, and one not always satisfactory when used, is the pneumatic speculum of Siegle (Fig. 10).

This speculum is closed at the wider end of its box-like portion by a plate of glass set in air-tight and at an angle such as will obviate reflection of light from its surface back to the eye of the examiner. At the side of the box is a perforated nipple for the attachment of the tube shown in the figure, while to the end opposite the glass plate may be screwed any one of three, four, or more sizes of conical ear-speculum. Such a speculum is shown attached in the accompanying illustration.

It is well that each of these conical specula should be covered on the outside with soft rubber, and should be well greased before its insertion into the auditory canal. Two things are requisite to proper insertion of this instrument,—viz., such direction and such depth of entrance as will insure a good view of the membrana tympani, and a tightness of fit which shall convert the canal and the interior of the speculum into a common and nearly air-tight cavity. Simultaneous attainment of both is not always easy.

FIG. 10.



Siegle's speculum.

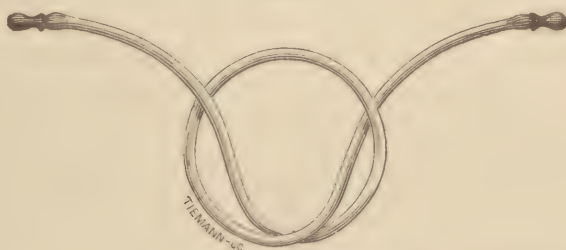
After a proper primary insertion of the speculum,—that is, its insertion until a good view of the membrane is had through it,—the observer is alternately to blow into and exhaust the air from the instrument through the medium of the rubber tube shown in the figure, either holding the distal end of the tube in his mouth or slipping it over the nozzle of a small air-balloon. The alternate condensation and rarefaction of air thus practised

show to the eye of the examiner alternating inward and outward excursions of the drum-membrane, in whole or in part, and also not infrequently, and always inconveniently, more or less similar excursion of the lateral walls of the auditory canal. Rarely does the examiner succeed in so fitting the speculum to the canal as to obviate leakage of air during this process of alternate rarefaction and condensation, yet even with such leakage sufficient power can be exerted to measure roughly the mobility of the membrana tympani, and care must always be taken to secure a good view of the membrane before and during these abrupt alterations of air-pressure, lest rupture or undue stretching of atrophied areas in the membrane should result therefrom. The especial object in view in using the Siegle speculum is determination of the mobility of the membrana vibrans as a whole, and consequently of the mobility of the attached malleus, in contradistinction to mobility of certain more or less limited areas of the membrane.

Thus far we have considered diagnostic methods and apparatus specially adapted to inspection of the auditory canal, of the membrana tympani, and such intra-tympanic structures as are to be seen through the latter. We come now to the consideration of several methods of inflation which are used for determination of the greater or less patency of one or both Eustachian tubes and of the relation subsisting between such greater or less patency and the disturbed function of the ear.

The patency of the Eustachian tubes is roughly measurable by inflation in various ways,—viz., by the degree of force requisite to insure inflation, by the alteration in hearing-power immediately resultant upon such inflation, by the loudness of the sound and acuteness of the sensation of pressure in the drum-cavity experienced by the patient at the moment of inflation, or by the loudness of this sound conveyed to the examiner's own ear through the medium of Toynbee's auscultation-tube (Fig. 11). The patency of

FIG. 11.



Toynbee's auscultation-tube.

the tubes is also measurable by comparison of the position of the drum-membrane immediately before with its position directly after inflation; although the chief object attained in such comparison is a measure rather of the mobility of the membrane than of the patency of the tube leading to the tympanic cavity.

Other diagnostic uses of inflation are the determination by its means of

the existence of a perforation in the drum-membrane when hidden from view through stenosis of the auditory canal; the extrusion of fluid through a perforation during inspection by mirror, and consequent sharper demarcation of a perforation outline; the better diagnosis of effusion present within a closed tympanic cavity, the act of inflation aiding such better diagnosis by causing a shifting of a previously only suspected fluid line, or in cases where perhaps no line whatever had been observed, by so aerating the fluid-filled chamber as to reveal through the translucent tympanic membrane a multitude of air-bubbles.

Before proceeding to discuss the three chief methods of inflation let it be said that when decided pain in the ear exists, or even when in the absence of marked pain an acute inflammation of the tympanum has been diagnosed, it is generally wise to defer any inflation whatsoever until the marked pain has diminished or the acute stage of the middle-ear inflammation has subsided. Moreover, for important reasons which I will not here stop to specify, it is politic never, under any circumstances, to inflate by any method until a good view has been obtained of the drum-membranes.

Be it remembered that I am here speaking of inflation as an aid to diagnosis; with inflation as a means of treatment this article is not concerned, yet my personal view regarding its advisability when so used may be inferred from what I have just said of it as a procedure in diagnostic examination.

The simplest and most desirable method of inflation is that which bears the name of Valsalva. It is chiefly of use when the observer desires to watch the effect of the inflation upon the drum-membrane and has no assistant to inflate for him by one of the other methods. The patient is the operator of the Valsalva inflation. Closing his mouth and holding his nose tightly pinched, he makes a more or less strong expiratory effort until he feels or the observer sees that the air, so compressed within the pharynx and nostrils and mouth, has crowded its way through the Eustachian tube into the tympanum. Valsalva's method is objectionable because its execution involves congestion of the cerebral vessels, of course including those of the tympanum. It is comparatively unsatisfactory in that it is weaker in action than other methods. It is less serviceable when employed together with the so-called otoscope for auscultatory diagnosis of tubal stenosis and of effusion within the drum-cavity than are the two other chief methods of inflation.

These other two methods are inflation by means of an air-compressing bag used either without or with the Eustachian catheter. Inflation without the catheter is effected through the nose; when the catheter is used, it is commonly introduced through one of the nostrils, but may be inserted through the mouth. In inflating by a bag alone the patient is directed to swallow at the moment of compressing the bag, or else to close his mouth and quickly puff out his cheeks at that moment, or else to say "a," or preferably some guttural sound such as "hie" or "kick." When water is

swallowed and inflation produced by compression of the air-bag, we have the typical method of Politzer, a method in which, by the mechanical action of the muscles of the pharynx, two things are simultaneously accomplished,—viz., isolation of the pharynx vault from the cavity of the lower pharynx and a practical temporary obliteration of the buccal cavity, and also a simultaneous opening of the pharyngeal mouths of both Eustachian tubes. If the patient says “hic” or “kick,” after the Gruber modification of this general method, the shutting off of the naso-pharynx is less firmly accomplished and the Eustachian orifices are less strongly and widely pulled open. If he puff out his cheeks we have a sort of modification of the Valsalva method of inflation, but one differing in an important particular from the true Valsalva method,—viz., in that this modified procedure makes the examiner and not the patient apply all or most of the inflating force, and thus precludes the occurrence of the objectionable cerebral congestion which ensues upon employment of the patient’s lungs and thoracic muscles as an air-pump.

Thus far we have spoken of the part played by the patient in the act of inflation. Essentially this part is an opening of the way to the force exerted by the sudden compression of air. The compression is effected by means of a soft-rubber balloon (Fig. 12), commonly and justly known as the Politzer bag. Such a bag should be of a size readily grasped by the surgeon’s hand in such position as to insure its forcible and complete compression by sudden closure of the encircling thumb and fingers; it should be pear-shaped and capped with hard rubber at its smaller end, said cap terminating in a conical or nipple-shaped nozzle made of proper size to fit a Eustachian catheter. There need be no air-valve, the sole opening being that through the nozzle. When a valve is provided (Poltzer himself uses none) it should be placed at some point in the hard-rubber cap, and not, as is sometimes done, at the larger end of the soft-rubber bag.

For establishing a communication between the cavity of such a bag and that of the nose no other contrivance is needed than a short piece of rubber tubing, thick-walled, and fitting tightly over the nozzle; but it is better to use some form of nose-piece and to connect this with the bag by a moderately long piece of tubing.

A good practical rule in regard to size and shape of nose-piece and length of connecting tube is that laid down by Dr. Buck. The hard-rubber nose-piece used by him is

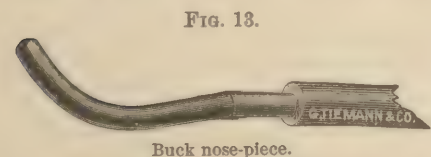


FIG. 13.

Buck nose-piece.

shown in Fig. 13; it is small in diameter, measuring but three and a half millimetres in thickness, and has a large calibre,—far larger in proportion

FIG. 12.



Poltzer bag.

to its size than have most ready-made nose-pieces,—its internal diameter being two and one-fourth millimetres. The curve as well as the size of the instrument is correctly shown in the figure. When in use, the terminal half-inch of its length goes within the nostril, the succeeding half-inch rests against the upper lip. In common with other forms of tubular nose-piece, it is to be inserted at the extreme lower corner of the nostril. As to the curve, it is remarked by Dr. Buck that this is easily under the control of the purchaser, brief heating over a lamp rendering the rubber pliable. As to calibre, the present writer will state for the encouragement of his readers that he once succeeded in procuring a ready-made nose-piece of celluloid that was a trifle superior to that described by Dr. Buck, although not so small as to outside diameter as his instrument; its inside diameter measured three millimetres, its diameter “over all”—if I may adopt this yachting term—was four millimetres.

With regard to the connecting tube of soft rubber, it should fit closely over the nozzle of the inflating bag and should fit the nose-piece very tightly :

FIG. 14.



Politzer's method of inflation of tympana.

it is best that this soft-rubber tube be thick-walled and as short as consists with the avoidance of sudden twisting of the nose-piece *in situ* when the connected inflating bag is compressed. I myself advocate a length of about twelve inches. The respective advantages and shortcomings of shorter and longer tubes are briefly and clearly discussed in Dr. Buck's work already cited.

The tubular nozzle inserted into the outer corner of the nostril and held firmly in position by the thumb and forefinger, which compress and occlude the nostrils, is the better form for use in adults. Fig. 14, copied from Politzer, shows the nose-piece in position and the balloon, connected by a very

short bit of tubing, about to be compressed by the operator. The thumb and finger will occlude the nostrils better if applied directly over their entrance rather than as high up as they are shown in this picture; at least such has been the writer's own experience with his thumb and finger.

Concerning the proper moment for compressing the balloon: when water is swallowed it must be done almost directly after giving the order to the patient to swallow and synchronously with his obeying this order, a fact well ascertainable by noting the rise of the larynx at the moment of beginning the act. It is best that but little water should be taken into the mouth; a teaspoonful suffices: the taking of more may be attended with inconvenience to both patient and physician. As was observed by Dr.

Buck, the sooner the order to swallow can be given to a patient whose nostrils have been occluded the better and the more satisfactory the inflation. When no water is used, the compression should, of course, be synchronous with the patient's phonation of "a," "hic," or "kick," or with the sudden puffing out of his cheeks. In young children water cannot be used; in older children it need rarely be used; babies commonly phonate after a method of their own which is very effectual: older children may be asked to say "a" or a guttural, but simple inflation per nares will suffice in many cases, and the younger the child the more apt for anatomical reasons (greater patency of tube orifices, etc.) will it be to answer every purpose. Children do not easily tolerate the tubular nose-piece, and it is in them more apt to cause abrasion and epistaxis.

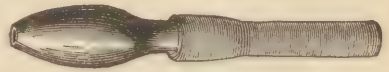
Hence a conical nozzle fully filling one nostril and leaving but one to be occluded by digital compression is a desirable variety for use in their case. Such a conical nose-piece made of hard rubber is

shown in Fig. 15.¹ It should not generally be used for adults, as it is impossible to render the nasal cavity as air-tight when the conical nose-piece is used as it may be made by close compression around the small tubular nose-piece. The conical nose-piece may, however, suffice, and will prove more comfortable to an adult having exceptionally sensitive nostrils.

When the ears are inflated by either modification of the method just discussed, the success of the inflation may be known by an immediately resulting alteration in the hearing-power; by a changed position of the drum-membranes effected thereby and observed either during inflation or directly thereafter; by the sensation and sound felt and heard in the ears by the patient himself; and by the sound conveyed from the patient's to the examiner's ear through the medium of the auscultation-tube of Toynbee, the so-called Toynbee's "otoscope." This instrument, already shown in Fig. 11, consists of a simple flexible rubber tube about three feet long and connecting two nipple-shaped ear-pieces, one marked by a ring or by its color as that designed for the examiner's ear, the other, unmarked, for use in the patient's ear. This marking for differentiation of one end is unnecessary, inasmuch as both ear-pieces should be kept constantly and scrupulously clean. The method of wearing this so-called "otoscope" is shown in Fig. 16, an illustration borrowed from Dr. Charles H. Burnett's work on diseases of the ear.²

In practising inflation by the Politzer bag it is desirable to remove the nose-piece from the nostril after each compression of the bag, and to wipe it carefully upon a towel, maintaining the pressure upon the bag unrelaxed

FIG. 15.



Poltizer nozzle.

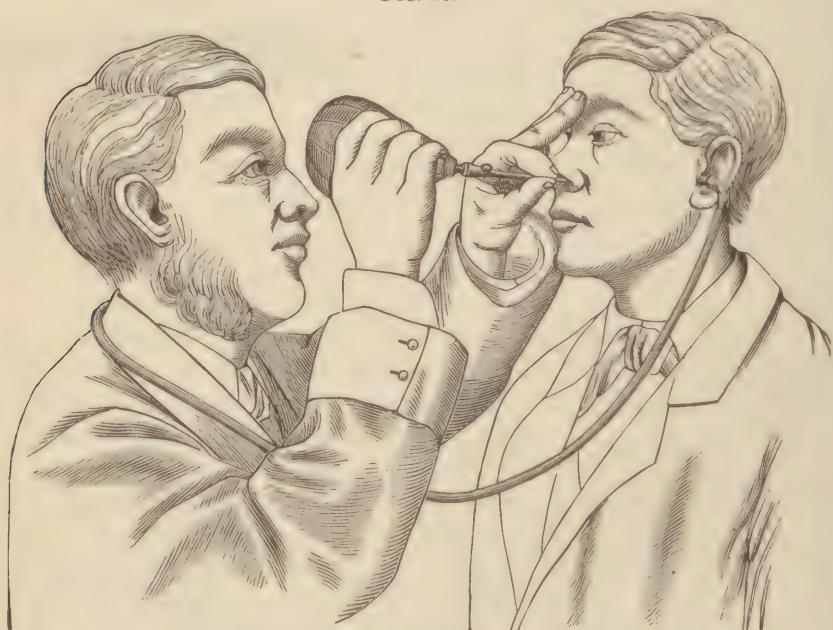
¹ Equally good, perhaps better, is the larger and more obtuse glass nose-piece commonly sold by the instrument-makers.

² *The Ear, its Anatomy, Physiology, and Diseases*, by Charles H. Burnett, A.M., M.D., Henry C. Lea & Co., Philadelphia.

until subsequent to such careful wiping. Thus may be avoided suction of nasal secretion into the nose-piece or connecting-tube, and this rule, for common decency's sake, should be observed even when the air-bag is provided with a valve. I think it allowable, though not altogether advisable, to omit this removal, wiping, and maintained compression after each expulsion of air, when using the blunt nose-piece, and desiring to make several inflations in rapid succession in the case of a young child, provided this more careless and less cleanly method be followed only when employing a bag provided with an air-valve.

The nose-pieces, both tubular and blunt, should, of course, be carefully washed both inside and out after use on each patient, and it is well also to

FIG. 16.



Burnett's method of using auscultation-tube.

wash the soft-rubber connecting-tube by holding it under a stream of water. The calibre of tube and nose-piece must be perfectly freed from water before they are used.

For auscultatory diagnosis the method of inflation through the Eustachian catheter is unquestionably superior to all other methods. One advantage which it possesses is that the entire force of the air-current, or nearly the entire force, is expended upon a single Eustachian tube and tympanum. It is true that by a modification of the method without catheter more of the inflating force can be directed to one than to the other tube and ear (*viz.*, by that modification in which the patient's head is held bent forward and to the side opposed to the ear which we desire chiefly to affect, and the opposite meatus being stopped by the patient's tightly-inserted finger, inflation

is performed through the nostril furthest from the ear which is to bear the brunt of the shock of compression); yet no such modification can take the place of inflation by catheter when unilateral examination is the object specially sought or where diagnosis is to be made by auscultation. The noises of the patient's swallowing, phonation, or blowing are eliminated when the catheter is used, and by substituting direct inflation into the tube-mouth, or at least close against the latter, for the method of less direct inflation per narem combined with sudden condensation of air confined within the nostrils and pharynx-vault, it is evident that a greater force will be apt to be exerted, and that louder sounds will be apt to be conveyed both to the patient's ear and to that of the observer who is using the auscultatory tube.

A well-known aurist of New York City, and one who quite strongly advocates the Eustachian catheter as an instrument in therapeutics, speaks rather disparagingly of its use in conjunction with the auscultatory tube, which, as he justly observes, does not deserve the name "otoscope," and to which he applies the more correct term stethoscope. "I believe," he says, "it will be found very difficult to distinguish sounds proceeding from the pharyngeal mouth of the tube from those produced in the cavity of the tympanum, and I do not therefore attach that importance to the use of the stethoscope in this manner which has been usually ascribed to it; but I rely more upon the appearances of the membrane of the tympanum after the air has been forced in, with some attention also to the sensations of the patient as to where the air is felt, than upon the use of the diagnostic tube. I very rarely make use of the instrument" (in diagnosis).¹ Whether or not we agree with this opinion respecting the Toynbee "otoscope" used in conjunction with the Eustachian catheter, it yet remains true that the method by catheter is in two ways superior to other methods of inflation, viz.: in the fact that by it greater power is exerted, and in that the exercise of this power may be far more strictly limited to a single ear; hence inflation by catheter deserves mention among the means of diagnosis.

The Eustachian catheter is shown in Fig. 17. It consists of a tube about six inches in length, made of hard rubber, of coin silver, or of German silver, curved towards its smaller end as shown in the illustration, and provided near its wider end with a ring or with some other mark attached so as to serve during introduction as indicator of the direction taken by the curved distal end. With the German silver catheter I am not familiar. Dr. A. H. Buck speaks strongly against its use, saying that it has nothing to recommend it save its cheapness. He prefers the silver catheter,—provided it be not too sharp at its inner end, and therefore liable to abrade the tissues,—on the ground of its being more easily so constructed as to give a maximum calibre with small diameter than is the

¹ A Practical Treatise on Diseases of the Ear, by D. B. St. John Roosa, M.D., LL.D., William Wood & Co., New York, 1891.

hard-rubber instrument; but he warns readers of his book that "very many of the silver catheters sold in the shops are even less serviceable than those made of hard rubber."¹ For "a good, serviceable Eustachian catheter" of average size, he gives the following dimensions as to diameter and calibre: for the former three and a half millimetres; for the latter two and a quarter or two and a half millimetres.

FIG. 17.



The illustration herewith presented is copied from Dr. Adam Politzer's classical work on aural diseases,² and is there presented as the picture of a hard-rubber catheter "of medium size." The instrument need not, however, be quite so long as there depicted, and the diameter is rather too large, in my opinion, for any but the largest size of the instrument. Three instruments in my possession, purchased of Reiner, of Vienna, and corresponding in shape with the one here shown, have the following dimensions as to diameter and calibre: the largest is three and a half millimetres thick and its calibre is about two millimetres in diameter; the next smaller measures three millimetres in outside and one and three-quarters millimetres in inside diameter; the smallest, two and a half millimetres thick, measures one and one-half millimetres across its beak at the tip. The inside diameter at the wider end—the funnel-shaped end—is, of course, the same in all three instruments, for this wider end is intended to fit the hard-rubber nozzle of the Politzer inflating bag.

One word with regard to the shape of this nozzle. Some aurists prefer the conical nozzle, which can be deeply inserted into the funnel-shaped end of the catheter. Others, and among them Dr. Buck, prefer the nipple shape for the nozzle of the bag, on the ground of its being less apt to become too tightly fixed in the catheter, while fitting tightly enough for all practical purposes.

As to the method of introducing the catheter, I purpose to describe briefly those three of the many methods or modifications of this procedure which are perhaps the easiest to be followed and which are the ones most commonly attempted. Other modifications will be found discussed at length in some of the treatises upon aural disease, and notably in that of Prof. Victor Urbantschitsch,

¹ A. H. Buck, *op. cit.*, p. 132.

² *Lehrbuch der Ohrenheilkunde*, etc., by Dr. Adam Politzer, published by Enke, of Stuttgart, 1878.

of Vienna,¹ by whom the subject of catheterization of the Eustachian tube is very exhaustively treated, all possible obstacles to its accomplishment mentioned, and notice taken of accidents more or less serious which may occur during its performance. With these possible mischances he who purposes employing this method of diagnosis will do well to become familiar. I shall touch upon a few of them at a later point in this paper, but shall pass over their discussion in this place as being almost superfluous in an article which pretends to do little more than barely to sketch in words the procedure of Eustachian catheterization.

The physician should sit facing his patient, and should make at least an anterior rhinoscopic examination as a preliminary step to the introduction of the catheter, endeavoring in this way to gain information as to hinderances likely to be met and as to the nostril preferably to be selected for the passage of the instrument. Whenever possible, the catheter should be passed through the nostril corresponding to the ear about to be tested by inflation. Immediately after use on any patient the instrument should be most carefully washed both outside and inside, and it is well that a disinfectant, such as bichloride of mercury or carbolic acid, in all cases, certainly in all suspicious cases, should be added to the water in such washing. After being washed and disinfected, the inside of the catheter must be freed from fluid by use of the air-bag: at the time of next using let the physician ascertain by testing with the Politzer bag whether the catheter be quite pervious and free from any foreign body, solid or fluid. It is only after such test and after assuring himself that the catheter is surgically clean that the physician can be properly considered as ready for the first step of its introduction. The patient on his part should clear his nostrils by blowing his nose. The Politzer bag and the auscultation-tube must be placed where they can readily be reached. Now let the examiner with his left thumb tilt up the point of the patient's nose, while with his right hand grasping the catheter lightly and holding it almost vertically and with the curve of its tip directed towards the patient he inserts the tip of the instrument to a point just beyond the ridge in the floor of the nostril which exists at a distance of about half an inch from the meatus. Then let the outer end of the catheter be raised so that its tip shall forthwith hug the floor of the nostril, the shank being thenceforth held in a horizontal position, and let the instrument be steadily but very gently pushed forward until it is felt to impinge against the posterior wall of the pharynx. Should the catheter in the course of this introduction show a tendency to rotate around its long axis, it should be allowed to do so, but care must be taken always to hug the floor of the nostril at the very start and as soon as the entrance ridge has been passed. No violence or approach to violence is permissible in the introduction of a Eustachian catheter at any stage of the process, and particularly is this true of the latter stage when the

¹ Lehrbuch der Ohrenheilkunde, Vienna and Leipsic, 1890.

instrument has entered the cavity of the pharynx vault. When an obstacle is met that tempts the examiner to the use of force, let the catheter be at once withdrawn, and let the process begin again from the start, either with the same instrument or with one of smaller diameter or slightly different curve. Whether or not the instrument have exhibited a tendency to the rotation about its long axis above mentioned during the passage of the nostril (and such rotation may even amount to a complete *tour de maître*), its beak on reaching the free space of the pharynx vault should either point downward of itself, as at first, or should readily assume this position on attempted rotation by the examiner.

When the instrument has been made to impinge beak downward against the back wall of the pharynx, the stage of the process which is shared in common by all three of the methods of introduction herein to be described has been completed. From this point on we may adopt any one of the following three methods.

(a) Grasping the catheter lightly between the thumb and forefinger of the left hand at its point of exit from the nostril, and steadying the instrument so grasped by resting the three remaining fingers of that hand along

FIG. 18.



Air-douche with the india-rubber balloon.

the ridge of the nose (see Fig. 18), the examiner will with his right hand rotate the beak of the catheter outward so that the index or tell-tale ring shall occupy an almost horizontal position. He will then withdraw the instrument slowly until he feels that the beak (which in its nearly horizontal position lay within the so-called Rosenmüller's fossa behind the Eustachian tube) has passed over the posterior prominent lip of the tube-mouth; and when it occupies this position abreast of

the tube-mouth a further rotation about its long axis in an outward direction, until the index ring points approximately towards the outer canthus of the corresponding eye, should bring the inner end of the catheter into the mouth of the tube. But if at this point in the procedure the patient experience great discomfort from the instrument, and especially if it hurt him to swallow, the examiner will have cause to believe that he has not succeeded in reaching the tube-mouth (Buck, *op. cit.*); and, in view of the possibility of an abrasion of the mucous membrane, he will do wisely to go back with the catheter to the posterior pharynx wall, and either repeat the withdrawal and rotation just described or else follow one of the other two methods about to be set forth.

(b) Grasping the catheter as in the former method, let it be rotated in-

ward instead of outward, and so that the ring shall lie quite horizontally. Then let the catheter be withdrawn until the posterior edge of the septum narium bars its further outward progress. Then let the beak of the instrument be rotated outward through an angle of about two hundred and twenty-five degrees, or until the ring points, as in the former method, to the outer canthus of the patient's eye. Failing to reach the tube-mouth by both of these methods, or (and more especially) in case great stenosis forbids introduction of the catheter through the nostril corresponding to the ear we desire to inflate, recourse may be had to the third modified method.

(c) By this method we attempt to reach the mouth of the Eustachian tube through that nostril which is farthest removed from it. To succeed we shall require a catheter of longer and sharper curvature than is possessed by the ordinarily-used instrument. After reaching the back wall of the pharynx with the curved beak of the catheter as in methods *a* and *b*, we turn the point horizontally towards the other nostril and withdraw the curved end until it is stopped by the septum as in method *b*. Further rotation in this same direction should cause the tip of the catheter to engage in the Eustachian orifice before it has described an arc, during such further rotation, of more than forty-five degrees. The point of the instrument before beginning and during this final rotation of forty-five degrees or less should be somewhat crowded over towards the orifice we are seeking to engage it in, by a slight lateral shifting of the outer end of the catheter in a contrary direction.

Introduction of the Eustachian catheter is facilitated at the initial stage of the process by cautioning the patient against screwing up his face or firmly closing his eyes. Should violent and convulsive movements of swallowing or gagging ensue when the beak of the instrument reaches the pharynx, let the patient be directed to breathe through the nose with firmly-closed mouth while the instrument is held perfectly still by fixation with the thumb and forefinger of the left hand. These convulsive movements nevertheless persisting, let the catheter be withdrawn. Faintness and fainting as reflex phenomena have been in rare instances observed to result during the introduction of the Eustachian catheter. For other still rarer accidents known to have ensued at this stage of the process the reader is referred to Prof. Urbantschitsch's work already cited.

The chief danger in catheterization is that of emphysema. To avoid risk of its occurrence, let the examiner use no instrument having a sharp-edged distal opening; let him abstain from violent or impatient efforts at introduction when he meets with obstacles thereto; let him be reasonably certain that the Eustachian orifice has been reached ere passing to the final step of the process,—to wit, the inflation or attempted inflation of air; let him eschew any method of inflation more forcible than that by manual compression of the Politzer bag.

How shall the examiner after carefully following the first steps of the introduction be reasonably assured of having reached the Eustachian orifice?

First, by finding a resistance to further outward and upward rotation of the catheter, and by observing that the instrument causes no marked discomfort to his patient, especially when the latter makes a movement of swallowing; secondly, by testing the permeability of the catheter and tube together by gentle use of the inflating bag combined with the auscultation-tube. As soon as he thinks he has properly adjusted the catheter let him hold it fixed with the left hand while with the right he inserts one end of the auscultation-tube into his own ear (preferably his left ear), directing the patient to place the other end of the tube in the ear to be tested; and then, taking the inflating bag in his right hand, let him adjust its nozzle against or within the wider outer end of the catheter, holding the bag as shown in Fig. 18. In compressing the bag care must be taken not to shove the catheter forward. After each compression the bag, whether provided with an air-valve or not, must be carefully removed from the catheter without any relaxation of grasp and be refilled for renewed inflation only when so removed. The sounds conveyed to the ear of the patient and to that of the observer by the auscultating tube are to serve as a partial indication of the permeability of the Eustachian tube. They are also guides to the expert examiner in estimating the degree of such permeability and in determining the presence or absence of fluid within the tympanic cavity. He who has had no clinical drill in introducing the catheter will be very imperfectly instructed in its use by this or by any merely written account of the process. With regard to the precise nature of the sounds heard through the auscultating tube I will merely remark that successful inflation through a pervious Eustachian tube gives rise to sounds, moist or dry, which seem close to or at times actually within the ear of the examiner himself; while unsuccessful inflation causes more distant sounds only to be heard. Clinical experience alone can teach this point, and again I would remind my readers of Dr. Roosa's adverse criticism upon the auscultating tube or aural stethoscope, the so-called "otoscope," as a diagnostic instrument.

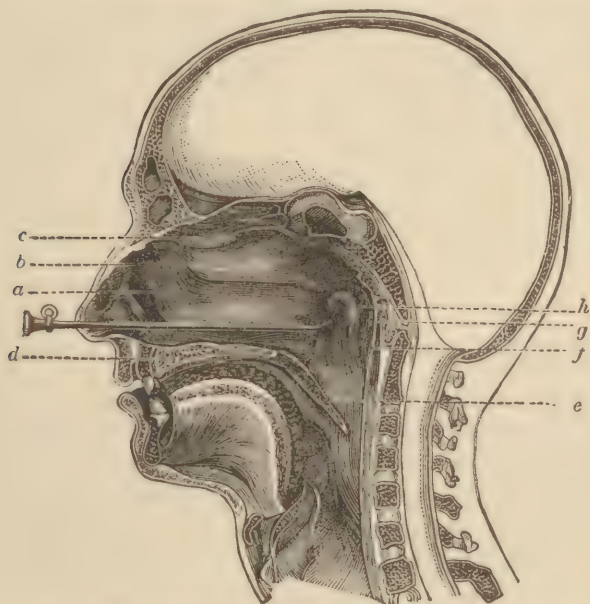
Should emphysema of the submucous tissues be either ascertained or suspected at any moment during the act of inflation, let the inflation cease at once. For the symptoms, dangers, and treatment of this emphysema I refer my readers to special treatises on diseases of the ear and to those on the surgery of the larynx and pharynx.

To withdraw a Eustachian catheter, let its beak be first rotated so as to point downward; then, holding the wide mouth of the instrument very lightly between the tips of the first and second fingers of the right hand, let it be drawn gently outward and downward in a curved direction and suffered to rotate about its long axis as freely as it chooses during the extraction. Fig. 19, copied from Prof. Politzer's book already cited, is here introduced as a rough reminder of the anatomical relations to be borne in mind by the user of the Eustachian catheter.

Before concluding this paper I must add that no examination of any

case of aural disease can be considered complete which omits careful investigation of the nasal passages and pharynx vault. The former should be examined by the method of anterior rhinoscopy; the condition of the pharynx vault can in many cases be ascertained with sufficient accuracy for

FIG. 19.



VERTICAL SECTION OF THE NASO-PHARYNX, WITH THE CATHETER INTRODUCED INTO THE EUSTACHIAN TUBE.—*a*, inferior spongy bone; *b*, middle spongy bone; *c*, superior spongy bone; *d*, hard palate; *e*, velum palati; *f*, posterior pharyngeal wall; *g*, Rosenmüller's cavity; *h*, posterior lip of the orifice of the Eustachian tube.

the purposes of the aural diagnostician by merely digital examination, but the examiner should be prepared, at least in the case of adult patients, to test the condition of the pharynx vault by ocular inspection, *i.e.*, by posterior rhinoscopy. Descriptions of these and other methods of examining the nose and naso-pharyngeal space are to be found elsewhere in this volume.

CONGENITAL MALFORMATIONS, CUTA- NEOUS DISEASES, MORBID GROWTHS, AND INJURIES OF THE AURICLE.

BY EDWARD B. DENCH, PH.B., M.D.,

Aural Surgeon, New York Eye and Ear Infirmary; Member of the New York Academy
of Medicine; Member of the New York Otological Society.

CONGENITAL MALFORMATIONS OF THE AURICLE.

IN the description of congenital malformations which may occur in this region I shall follow somewhat the classification of Gradenigo,¹ who divides these anomalies into two great classes: first, those involving the entire auricle; and, second, those affecting a portion of this organ.

With reference to causation little can be said. Morel² has called attention to the fact that deformity of the external ear is not uncommon among the insane, using this as an argument in support of his statement that mental and physical degenerations go hand in hand, as it were. Gradenigo, in his statistics, fails to trace in all cases a marked relation between a deficient mental condition and anomalies in conformation of the external ear. Heredity no doubt plays an important part in the production of these malformations, since we not infrequently find similar deformities in different members of the same family.

Returning now to our classification, we find that the first class includes anomalies involving the entire auricle. Under this class we consider asymmetry of the auricles, and also abnormalities in size, location, and position. In a case reported by Szenes³ one auricle was normal, while the other, although properly formed, was uniformly reduced in size; the meatus also was very small and the sense of hearing entirely absent. Lannelongue⁴ reports a curious instance of anomalous location of the auricles, in which they were situated in the hyoid region of the neck.

Under anomalies of position we may also mention those cases in which one or both ears are very prominent, standing out from the side of the head

¹ Archiv für Ohrenheilkunde, vol. xxxiii. p. 1.

² Traité des Dégénérescences de l'Espèce humaine, Paris, 1857. (Atlas.)

³ Archiv für Ohrenheilkunde, vol. xxvi. p. 143.

⁴ Affections congénitales, Paris, 1891, vol. i. p. 487.

in so marked a degree as sometimes to constitute an actual deformity. Such instances have been observed by Gruber,¹ Bacon,² Ely,³ and others.

Such patients usually apply for relief on account of the unsightly appearance which the deformity causes, the function of hearing not being affected.

Another condition is occasionally met with in which the auricle is applied to the side of the skull in such a position that the lower extremity of the lobule points downward and forward, instead of downward. Such a condition is not an uncommon occurrence in musicians, as noted by Lombroso.⁴

When we come to consider anomalies in formation of the various portions of the auricle, we are at once impressed with the fact that classification is almost impossible. An attempt, however, will be made to call attention to some of the deformities which may occur in the individual portions of the organ.

Anomalies of the Helix.—Wagenhäuser⁵ cites an instance in which the upper part of the helix was absent upon both sides, the auricle being otherwise normal; while Stetter⁶ has reported a case in which the helix and antihelix dropped downward in such a way that the upper portion of the auricle obstructed the orifice of the canal, thus impairing the hearing. A plastic operation relieved this condition. Schubert⁷ reports a case somewhat similar to the above, in which there was a flap-like helix. In addition, however, there was other deformity. The so-called Darwinian ear and the satyr ear really constitute moderate congenital anomalies in the form of the helix.

Anomalies of the Antihelix.—This portion of the auricle may present certain anomalies. It may be so strongly developed as to project beyond the line of the helix when the ear is looked at from behind, giving rise to a peculiar appearance. Schubert⁸ has cited an instance of this deformity which he denominates "pointed ear." In this case the superior crus of the antihelix was abnormally developed, and the helix was pushed upward, thus causing a deformity similar to that ordinarily termed the satyr ear. Gradenigo has observed that undue prominence of the antihelix is more common in females than in males, and that it is also more frequently met with in the insane and among criminals than in other individuals. I myself have observed one instance in which the antihelix was very promi-

¹ Lehrbuch der Ohrenheilkunde, Wien, 1888, p. 254.

² Archives of Otology, vol. xix. p. 17.

³ Zeitschrift für Ohrenheilkunde, vol. xi. p. 35.

⁴ Cited by Gradenigo, loc. cit.

⁵ Archiv für Ohrenheilkunde, vol. xix. p. 55.

⁶ Ibid., vol. xxi. p. 92.

⁷ Ibid., vol. xxii. pp. 51 and 52.

⁸ Loc. cit.

ment, projecting fully an eighth of an inch beyond the vertical plane of the helix when the ears were viewed from behind. The deformity was particularly marked upon the left side, and here also the lobule of the ear was remarkably small, the organ terminating almost abruptly at the antitragus. Upon the right side both deformities were less marked, although distinct. The intellect of the patient was normal.

Anomalies of the Lobule.—In the black race this portion of the auricle reaches an abnormal degree of development. The Kaffirs, by piercing the lobule of one side in a peculiar manner, form a pouch within it sufficiently capacious to carry tobacco, while upon the other side they carry in the perforation a small spoon or scoop of bone, for the purpose of removing the tobacco from its pouch when they desire to use it. Among the civilized races, however, anomalies in this region are comparatively rare, though Binder¹ has reported an instance in which the lobule was entirely wanting, while Szenes² cites a case in which only a rudimentary lobule was present, the external auditory meatus being wanting, and there being faulty development of the corresponding side of the face.

Another malformation which may occur in this region is that of cleft lobule. Blau³ cites an instance in which there was a double lobule upon one side. I have observed examples of this in my own practice, and in one case the conformation of the parts resembled so closely the deformity resulting from an ear-ring being torn from the ear, that it required the most positive statement of the patient to the contrary to convince me that the local condition was not the result of traumatism.

Anomalies of the Tragus.—Oeffinger⁴ cites an instance in which the tragus projected outward and forward, and then turned backward, covering the canal; while McBride⁵ has observed a case in which the tragus, antihelix, and auditory canal were rudimentary, while the lobule and antitragus were well developed.

Anomalies of the Antitragus.—Malformations of the antitragus are rare. Szenes⁶ mentions an instance in which two spurs of cartilage projected from the antitragus into the canal. No deformity of this kind has come under my own observation, and I believe them to be of exceedingly infrequent occurrence.

Microtia.—We have considered above the congenital deformities which involve the different parts of the auricle. We now come to the consideration of those instances in which the process of development has not per-

¹ Archiv für Psychiatrie, 1887, vol. xx. p. 2.

² Archiv für Ohrenheilkunde, vol. xxiv. p. 185.

³ Ibid., vol. xix. p. 205.

⁴ Zeitschrift für rationelle Medicin, 1868, vol. xxxi. pp. 1 and 2.

⁵ Edinburgh Medical Journal, April, 1881.

⁶ Archiv für Ohrenheilkunde, vol. xxvi. p. 140.

sisted to the formation even of a faulty or deformed auricle, but has resulted in so complete a malformation of the organ that its distinctive parts cease to be well defined. To this general class of malformations the name *microtia* is given. The condition is illustrated in Fig. 1. Not only is the auricle deformed in these cases, but coexistent lack of development may exist in contiguous structures. Schwendt¹ reports a case of double *microtia* in which the external auditory meatus was absent on both sides and in which a fistula existed upon the right cheek, communicating with a branchial cyst. Similar instances are cited by Heusinger,² Virchow,³ and Koslowsky.⁴

In addition to the deformity, this condition merits more than a passing attention from the fact that experience teaches us that when the auricle is deformed to this degree, in the very large majority of instances, this external deformity is attended with a serious malformation of those parts of the auditory apparatus which are necessary for the transmission and perception of sound, and moreover that even when sound can be perceived, the bony meatus and the deeper parts of the middle and internal ear are ordinarily so poorly developed that any attempt upon our part to restore the integrity of function of the parts must prove futile. Most frequently either the bony or the cartilaginous canal, and very frequently both, will be found wanting. Instances of this condition of malformation of the auricle in which closure of the cartilaginous or bony canal existed have been reported by Rose,⁵ Ockel, Glama and Wreden,⁶ Strawbridge,⁷ Duncanson,⁸ Kiesselbach,⁹ Truckenbrod,¹⁰ Ludewig,¹¹ and others. The deformity may exist upon both sides, as in the examples cited by Rose and Ludewig, or, as is most commonly the case, may occur upon one side only, as in the remaining cases cited above. Steinbrügge and Moos¹² cite an instance of this condition in which only the lobule was present, and this was so folded upon itself as to give rise to a cauliflower appearance. In addition to being malformed, it was also misplaced, being situated upon the ramus of the jaw, below and in front of the normal situation of the auricle. A somewhat similar deformity has been observed by Schubert.¹³ Kiesselbach¹⁴ reports an interesting case in which, in addition to *microtia* on one side, the auricle upon the other

¹ Archiv für Ohrenheilkunde, vol. xxxii. p. 37.

² Virchow's Archiv, 1864, vol. xxix. p. 358.

³ Cited by Schwendt, loc. cit. p. 45.

⁴ Virchow's Archiv, vol. cxv. p. 547.

⁵ Monatsschrift für Geburtshülfe und Frauenkr., vols. xxvii. and xxviii.

⁶ St. Petersburg Med. Zeitschrift, 1863, nos 9 and 11.

⁷ Transactions of the American Otological Society, 1875.

⁸ Edinburgh Medical Journal, March, 1878.

⁹ Gerlach's Beiträge zur Morphologie und Morphogonie, 1885.

¹⁰ Zeitschrift für Ohrenheilkunde, vol. xiv. p. 179.

¹¹ Archiv für Ohrenheilkunde, vol. xxix. p. 267.

¹² Zeitschrift für Ohrenheilkunde, vol. x. p. 15.

¹³ Archiv für Ohrenheilkunde, vol. xxx. p. 48.

¹⁴ Ibid., vol. xix. p. 127.

side was malformed. The deformed auricle may be variously situated with reference to the canal. Thus, in a patient seen by Knapp,¹ a rudimentary helix and lobule, present upon both sides, were found in front of the canal.

Polyotia.—This is a name applied to a condition occasionally met with, in which, instead of a single normal or deformed auricle upon either side, there exist upon one or both sides two of these organs, either completely developed, or, as is usually the case, both rudimentary. Instances of this condition have been observed by Knapp,² in which a second rudimentary ear was found in front of the right concha, with a dermoid cyst in the right cervical region. Mignot³ reports a case in which a second structure resembling an ear was situated in front of and below the tragus of the normal organ. It was attached to the tragus and also to the cheek, and contained no cartilage. Bürkner⁴ has cited an instance in which, in addition to a microtia, a wart-like appendage was present in front of the rudimentary lobule, thus constituting in reality a case of polyotia. A congenital aural fistula was also present in this patient. Examples of a somewhat similar deformity have been observed by Hartmann⁵ and Randall.⁶ In the case reported by this latter writer, in addition to the polyotia, there was a congenital aural fistula. In the instance of microtia cited by Rose⁷ a supernumerary auricle was also present. Quite recently I have met with a similar deformity in a child two months old, in whom the auricle upon one side was represented by a cutaneous fold containing in its upper part a small amount of cartilage. This was bent forward upon the cheek, covering the site of a normally-placed meatus. Upon its posterior surface was a well-defined groove, separating the cartilaginous from the non-cartilaginous portion. About three-eighths of an inch in front of the anterior margin of this part was a small, wart-like prominence, which, in my opinion, represented, not the tragus, but a rudimentary auricle. It was impossible to determine whether the auditory canal was present or not. The rudimentary organ first mentioned was freely movable, and just beneath its attachment a slight depression could be felt. The condition is well represented in Fig. 1. The auricle on the opposite side was normal, and there was no hereditary history.

From the above description, it will be seen that the conditions of microtia and polyotia may exist together, or they may occur separately. While the hearing is frequently impaired, a certain amount of hearing-power may exist with either condition. Thus, in the cases cited by Wreden,

¹ Zeitschrift für Ohrenheilkunde, vol. xi. p. 55.

² Transactions of the American Otological Society, Boston, 1879.

³ Académie de Médecine, December 2, 1879.

⁴ Archiv für Ohrenheilkunde, vol. xxii. p. 200.

⁵ Fourth Otological Congress, Brussels, Sept. 10 to 14, 1888.

⁶ Transactions of the American Otological Society, 1889.

⁷ Loc. cit.

Strawbridge, and Knapp the sense of hearing was to a certain extent preserved, while in Duncanson's case there was no hearing.

With reference to operative interference, the remarks already made concerning the probable absence of either the bony or the cartilaginous meatus, and possibly of both, should be borne in mind. Instances have been recorded by Knapp, Wreden, Kiesselbach, Ludewig, and Vali,¹ in which an attempt has been made to open the external auditory meatus. In Wreden's case, although the operation was partially successful, the canal could not be kept open; while in Kiesselbach's case the operation was partially successful in establishing such a canal. In Ludewig's case the attempt was also partially successful, although septic infection resulted after the operation, and the convalescence was greatly prolonged. In the cases reported by Vali and Knapp the effort to restore the external auditory canal was futile.



Microtia and polyotia.

If it seems desirable to perform an operation of this kind, the procedure consists in making an incision behind the deformed member, and, by means of the elevator, carefully lifting the organ forward. The region corresponding to the normal situation of the external auditory meatus should now be carefully examined, and any opening in the bone in this location should be enlarged by means of the gouge and chisel. The auricle is then replaced and the wound sutured, after which the soft parts over the newly-formed meatus are divided by means of crossed incisions, and the four small flaps thus formed are turned into the canal, and are held in position by a packing of gauze for a few days; later a tube of aluminum or rubber may be substituted. Too frequently, however, the deeper parts, if reached without accident, will be found to be seriously deformed. Thus, in the case reported by Rose,² in addition to the absence of the external meatus the tympanic ring was wanting, the ossicles were deformed, and supernumerary ossicles were present; while in the case cited by Steinbrügge³ the annulus tympanicus, the ossicles, and the foot-plate of the stapes were wanting. In Kiesselbach's case, also, the tympanic cavity was malformed.

It is only upon the earnest solicitation either of the parents or of the patient that any operation of this kind should be done. I am decidedly

¹ Archiv für Ohrenheilkunde, vol. xxxiii. p. 28.

² Loc. cit.

³ Loc. cit.

in favor of allowing these children to go on, for a number of years at least, without any attempt at operative interference, and especially if in early childhood we believe that the sense of hearing is present in the slightest degree. After they have attained such an age that this can be determined, it then lies with the patient or his friends as to whether an attempt shall be made to improve the condition. The dangers having been fully explained, and the responsibility taken by the patient, both with reference to life and to the restoration of function, I think we are at liberty to undertake the operation. For the external malformation very little can be accomplished by plastic operation in cases of marked deformity. For the deformity alone it seems that the best practice would be to amputate the auricle entirely, and resort to some artificial substitute. For the minor degrees of malformation, such as undue prominence or slight irregularities in conformation of individual portions of the organ, plastic surgery can do much to relieve the condition. If the auricle on either side is too prominent, the operative procedure consists in the removal of a crescentic segment of integument by means of two curved incisions immediately behind the organ. The anterior incision should follow closely the line of attachment of the auricle to the skull, and should lie either in the sulcus immediately behind the ear, or it may be made through the integument covering the posterior surface of the auricle, and parallel to this furrow in case the deformity is extreme. The exact location of the posterior incision will depend upon the size of the segment which it is necessary to remove in order to correct the deformity. Upon stitching the edges of the wound together the ears can be approximated to the head to the desired degree. This operation has been successfully performed by Ely, Bacon, Gruber, and others. In the instance cited by Stetter, a plastic operation upon the auricle itself was followed by a decided improvement in the condition. If undue prominence of the auricle is noticed early in childhood, a simpler procedure has been recommended, consisting in coating the posterior surface of the auricle with flexible collodion and, while this is still moist, holding the ear back upon the side of the head by means of a firm bandage. After the collodion has set the bandage may be removed, and the auricle remains in the position in which it has been placed. By repeating this procedure faithfully the undue prominence will gradually be relieved. In cases of polyotia, amputation of the supernumerary auricle will be the best practice.

Auricular Appendages.—Not infrequently we meet, in connection with otherwise perfectly normal auricles, with certain supernumerary appendages. These most frequently occur in the region of the tragus, but may be found rarely in other situations. In a case cited by Wendt,¹ there existed one process in front of the tragus and one on its inner side. The upper appendage, a short distance above its origin, divided into two branches; the lower was flat and about the size of a split pea, while the tragus itself was

¹ Archiv für Ohrenheilkunde, vol. iii. p. 31.

thickened. Bürkner¹ observed in a male aged eighteen two appendages in front of the left tragus; one was a sixth of an inch long, while the other was flat. A curious instance is cited by Barth,² in which a rudimentary mammary gland was found located just below the lobule of the auricle of one side. This appendage enlarged regularly during menstruation, and became more prominent and erect when the patient became emotional. Other instances of auricular appendage have been reported by Wagenhäuser,³ Erskine,⁴ and Burnett.⁵ One malformation of this example has fallen under my own observation. It occurred in a child aged thirteen months, in whom, just above the right tragus, which itself was somewhat rudimentary, there was present a process projecting outward and somewhat forward and upward, about three-quarters of an inch in length. The process contained cartilage. The deformity is well represented in Fig. 2.

The treatment of these appendages consists in their removal by means of the knife. The operation is an exceedingly simple one, and cannot be attended by any complication. In my own case the procedure consisted in circumscribing the base of the appendage by means of two crescentic incisions, one upon the anterior and the other upon the posterior aspect; the integument was then pushed downward for a little distance, and the cartilage was divided transversely with scissors at a deeper level than the cutaneous incisions. The edges of the wound were united by sutures, and recovery was rapid and complete.

FIG. 2.



Auricular appendage.

Fistula Congenita Auris.—Congenital aural fistula constitutes a deformity of the external ear which is of but little practical importance. It probably occurs as a consequence of arrest in development in either the formation of the auricle itself, or, as Virchow believes, it may represent an incomplete closure of the first visceral cleft. It is spoken of ordinarily as a somewhat rare deformity, but I am inclined to think that this is due rather to the fact that, as the cases present no clinical importance, they are either not observed or not reported, although the condition may exist quite frequently. The subject has been fully discussed by Schmitz,⁶ while in-

¹ Archiv für Ohrenheilkunde, vol. xvii. p. 183.

² Virchow's Archiv, vol. cxii. pt. 3.

³ Archiv für Ohrenheilkunde, vol. xxvii. p. 159.

⁴ Otological Section of the British Medical Association, 1888.

⁵ A Treatise on the Ear, 2d ed., Philadelphia, 1884, p. 211.

⁶ Inaugural Dissertation, Halle, 1873.

stances of the deformity have been reported by Schubert,¹ Wagenhäuser,² Burnett,³ Urbantschitsch,⁴ and others.

As has already been observed in discussing microtia and polyotia, fistula congenita auris may coexist with either of these conditions. Four cases of aural fistula have come under my own observation. In one case the deformity existed upon both sides to the same extent, and was located just above the tragus. In the second case, about one inch above the left tragus there was a depression a sixth of an inch in diameter, which admitted a probe for half an inch downward and inward, while upon the opposite side there was a depression or pit in the same situation, which did not admit the tip of the probe. The patient stated that other members of the family presented the

FIG. 3.



Fistula congenita auris.—a, fistula.

same deformity. In the third case, the one illustrated in Fig. 3, *a*, at a point above the tragus, one-third of an inch in front of the posterior edge of the helix and opposite the lower division of the antihelix, there was a small fistulous opening, which admitted the probe for the distance of half an inch, in a direction downward, forward, and inward. This tract was filled with sero-purulent matter. The patient had not been conscious of its presence. In the fourth case the malformation consisted in the presence of a minute pit, not admitting a probe, situated about the middle of each concha, being slightly more anterior upon the left side than upon the right. In an instance observed by Pflüger,⁵ a purulent discharge had occurred from the fistula on several occasions following

attacks of earache. If the opening of the fistula becomes closed, the secretion may collect to such an extent as to give rise to fluctuating tumor in the region of the tragus, as in an instance recorded by Urbantschitsch.⁶

As my own cases show, the fistula may vary in position and may be either unilateral or bilateral. In addition to the locations already given, it may exist in the helix or in front of the tragus. Burnett⁷ states that in some cases the fistula may lead into the tympanic cavity.

The only circumstances under which this condition may require treatment are those which attend a blocking up of the orifice of the fistula,

¹ Archiv für Ohrenheilkunde, vol. xxii. pp. 51 and 52.

² Ibid., vol. xxvii. p. 159.

³ Op. cit., p. 213.

⁴ Monatsschrift für Ohrenheilkunde, 1877, No. 7.

⁵ Ibid., 1874, No. 11.

⁶ Lehrbuch der Ohrenheilkunde, 3d ed., Vienna and Leipsic, 1890, p. 94.

⁷ Loc. cit.

leading to a retention of the secretion. In such an event a simple incision, with a thorough scraping of the walls of the retention-cyst, will probably result in a cure.

CUTANEOUS DISEASES OF THE AURICLE.

Intertrigo of the Auricle.—This affection develops most frequently in young children as a result of wearing tight-fitting caps, from the mistaken idea, so prevalent among the laity, that the external ear should be protected from cold and from draughts, even in warm weather. For this purpose the ears of children are frequently covered by means of a long kerchief tied over the head and under the chin, or the cap or hat is made in such a way that the auricles are entirely enclosed within it and pressed backward upon the head. In this manner the cutaneous surface of the auricle is brought into immediate contact with the integument over the mastoid region. As a result of this procedure the secretions from both cutaneous surfaces are prevented from escaping, and by the restless movements of the child the parts are rubbed against one another. From these conditions there results a loss of the superficial epithelium from one or both surfaces, giving rise to an area of greater or less extent which has been deprived of its epithelial layer, presenting a reddened, moist surface, whose edges merge imperceptibly into the normal skin. There is no elevation or depression of this eroded area, and in its early stages there is no infiltration of the underlying parts. If the condition is allowed to persist, we soon have developed an infiltration of the deeper cutaneous structures and the development of an eczema.

The removal of the superficial layer of the skin, with the exposure of its deeper layer, renders the cutaneous structures sensitive to external irritants, and consequently the patient is tormented by the intense itching of the parts. Efforts to relieve this by scratching simply result in an aggravation of the trouble. The general hygienic condition of the patient plays an important part in the severity of the affection. In a poorly-nourished child all the symptoms and local manifestations are present to a much greater degree than in a child who is otherwise in perfect health. A slight amount of local irritation in a strumous, anæmic, or poorly-nourished child will often develop a severe intertrigo, while the same cause might have no effect upon a healthy child. Heredity also undoubtedly constitutes an important factor, those children predisposed to cutaneous affections being much more easily affected by any slight local irritating cause than children in whom such a predisposition does not exist. While all these factors play an important part in the causation of the affection, the condition may occur in a child who is otherwise in perfect health.

The treatment consists in a restoration of the normal condition of the parts. The eroded surfaces should be separated by a thin layer of linen, which may be smeared with vaseline, cold cream, or olive or almond oil, or the denuded areas may be dusted with a toilet-powder, or starch, or oxide

of zinc, and a thin layer of dry linen interposed between them. It is well to avoid washing the affected portion of the integument with water while the erosion exists. It is scarcely necessary to say that the head-dress should be so arranged that a free circulation of air is permitted about the parts and the normal function of the skin promoted as much as possible. If not attended to promptly, a troublesome eczema may result.

Eczema of the Auricle.—This disease as attacking the auricle may manifest itself either in an acute or in a chronic form. An acute eczema of the auricle usually depends upon the same causes which produce eczema in other parts of the body. Underlying any such cutaneous affection we invariably find, I believe, either some constitutional diathesis, such as gout or rheumatism, a disordered condition of the *primæ viæ*, improper food, either insufficient in quantity or in quality, or of a kind not adapted to the particular requirements of the patient, irregular habits of life, or some obscure pathological condition which interferes either with the proper assimilation of food or with the proper elimination of the excretions of the body. In addition to general causes we find certain local conditions playing a prominent part in the production of an eczema of the auricle. Most prominent among these local conditions we should place a discharge from the external auditory canal, either from some pathological condition in this region itself or, most commonly, from a purulent inflammation of the tympanic cavity. I quite agree with Baratoux,¹ who considers that even where a local cause does exist, the fact that it produces an eczema is an evidence of some morbid systemic condition. This author believes that the so-called condition of scrofulosis plays the most important part in the production of this affection. I am inclined to think, however, that while scrofulosis, or perhaps better lymphatism, may be a prominent exciting cause, we frequently find the evidences of lymphatism, such as enlarged cervical glands, etc., as the result of the eczema.

A frequent cause of auricular eczema in children is the habit so much in vogue among the laity of keeping the ears of young children covered even in warm weather. The hoods so commonly worn by children almost always cover the auricle and press it backward upon the side of the head, thus bringing the integument covering the posterior surface of the auricle in contact with the skin behind the ear. In warm weather the natural heat and moisture of the parts are thus shut in and act as a poultice to the cutaneous surfaces held in apposition. As a result of the heat and moisture the superficial epithelium is macerated and is rubbed off by the motions of the child, giving rise to an intertrigo. If the exciting cause is not removed the cutaneous structures soon become the seat of an acute inflammation, which rapidly takes on the character of an eczema.

An acute eczema of the auricle first manifests itself by a burning of the

¹ Revue mensuelle de Laryngologie, March, 1881.

part, which soon changes to a condition of intense pruritus. In order to relieve this the patient scratches the offending region, and thus adds to the local irritation. The cutaneous surface becomes reddened, the whole cutis thickened, and then appears the characteristic eruption of eczema. This may either manifest itself in the formation of small vesicles, which may coalesce, or, what is more common, the entire cutaneous surface may lose its superficial epithelium, and the whole auricle assume an intensely red, moist, and raw aspect, from which the serum can almost be seen to exude. This same condition may obtain after vesicles have formed, coalesced, and ruptured. After the disease has persisted for some time, either with or without the formation of vesicles, the discharge from the moist surface assumes a more purulent character, which drying upon exposure to the air gives rise to the formation of crusts. The removal of these crusts is frequently attended with slight hemorrhage, and after their separation the process already described is repeated. When the condition arises from a purulent discharge from the canal, the concha is ordinarily the part first affected, although later, unless the parts are kept scrupulously free from the discharge, the entire auricle may become involved. Where local causes play the most prominent part, the disease is usually unilateral, provided the exciting condition is unilateral. Where, however, the constitutional element is the principal factor we are apt to find the disease bilateral. On the other hand, while a discharge from the meatus is one of the most prominent exciting causes of this condition, an eczema developing primarily upon the auricle may spread to the canal and give rise to troublesome symptoms, as in the case cited by Wendt¹ in which a persistent tinnitus depended upon this cause.

In addition to the manifestation upon the auricle, if the condition is neglected, the morbid process affects the cutaneous surface of the scalp behind the ear, and may serve as a starting-point of an eczema capitis. This is especially liable to occur in young children. As a result of the dermatitis of the auricle the cervical glands are not infrequently enlarged, particularly in patients of tender years. If the local disease remains unchecked it very soon ceases to be an acute affection, and we have set up a thickening of the deeper layers of the epidermis, constituting a chronic eczema, a condition which frequently baffles the efforts of the most skilful, and which never should be looked upon as an affection the cure of which will be a simple matter.

When the disease has assumed the chronic form we find the integument of the auricle thickened through its entire depth. The affected area may be limited to one portion of the auricle, as the concha, helix, or antihelix, or it may involve the entire organ. The part affected is of a dull pinkish-red color, the surface in places appearing glossy and polished, in other places covered with small, dry, white scales, which can be easily

¹ Archiv für Ohrenheilkunde, vol. iii. pp. 28 and 29.

separated, leaving a red, glossy surface as above described. The increased thickness of the integument is easily made out on palpation, and the parts feel dry and hard to the touch, the normal soft, elastic feeling characteristic of healthy integument being wanting. The patient complains of an intolerable itching in the part, and the efforts to relieve this only tend to aggravate the affection.

We do not, as a rule, anticipate any serious result to follow an eczema of the auricle. De Rossi,¹ however, describes a form of the affection which is followed by deep ulceration of the parts, the cartilage even becoming involved. He states that, as a rule, the affected individuals have been anæmic, but not always. I am inclined to believe, however, that there must have been some other cause than the eczema to account for the destruction of the cartilage, and should be inclined to regard the cases as instances of gangrene of the auricle.

The treatment of both the acute and the chronic form of the affection divides itself into the administration of internal remedies and the exhibition of local applications. Internally we must be guided by such general symptoms as may present. For the acute form we shall ordinarily find some error in the digestive apparatus. It is well, then, carefully to run over the diet of the patient and interdict such articles as are likely to interfere with his digestion. Any underlying diathetic conditions, such as gout or rheumatism, should be treated with the drugs particularly adapted to the removal of such diatheses. The exhibition of moderately large doses of alkalies, both in the form of Rochelle salt and of the bicarbonate and citrate of sodium, during the first few days of the attack, cannot be too strongly advised, and a moderate amount of the alkali should be kept circulating in the blood for a considerable period of time. Any local cause which may exist, such as a purulent discharge from the meatus, should be removed. If the disease is of the acute variety, our first efforts should be to relieve the intense dermatitis. This will probably be best effected by cold applications, and for this purpose we may use any evaporating lotion. Perhaps the familiar lead-and-opium wash in this acute stage answers as good a purpose as any, or the following may be used :

℞ Liquor plumbi subacetatis, fʒii;
Bismuthi subnitratiss, ʒss;
Morphinæ, gr. ii;
Glycerini, fʒi;
Aquæ rosæ q. s. ad ʒviii.

Sig.—Shake well before using.

This may be applied by moistening compresses in the fluid, changing them frequently. The same result may frequently be attained by dusting the part with some bland and unirritating powder, such as oxide of zinc, sub-nitrate of bismuth, starch, lycopodium, etc. Or, again, it may seem well

¹ Archiv für Ohrenheilkunde, vol. xxi. p. 193.

to make the application in the form of an ointment, in which case the following may be of service:

R Bismuthi subnitratiss, $\mathfrak{z}\text{ii}$;
 Acidi borici, $\mathfrak{z}\text{j}$;
 Morphinae, gr. j;
 Unguenti zinci oxidi, $\mathfrak{z}\text{ss}$;
 Petrolati q. s. ad $\mathfrak{z}\text{j}$.

Bürkner¹ has obtained most satisfactory results from the use of an ointment of boric acid and vaseline, in the proportion of one part of the former to four parts of the latter.

Eitelberg² strongly recommends an ointment containing creolin, in eczema of the auricle. The strength of the ointment must of course vary with the conditions met with. The above writer advises that the proportion be about one to fifty.

After the acute stage has passed away, or if the disease is not seen until the stage of incrustation, the use of any application containing water is contra-indicated. The crusts should be softened with oil, and then the application of the above ointment or powders can be made. After the crusts have been removed it is frequently advantageous to apply to the part a solution of salicylic acid in alcohol, of the strength of twenty to forty grains to the ounce, once or twice daily. In the interim the auricle should be protected from the air by the application of zinc ointment, cold cream, or any of the unirritating or slightly astringent ointments.

Knapp³ advises the removal of the crusts by means of an alkaline solution, after which the affected region is to be painted with a solution of nitrate of silver, of the strength of ten or fifteen grains to the ounce. These applications may be made daily, or even more frequently at first, and as improvement becomes more marked they are to be made less frequently. After the application of the silver solution, the parts are to be anointed with cold cream or the ointment of yellow oxide of mercury. Knapp has found this plan of treatment exceedingly satisfactory. I have never used the nitrate of silver upon the auricle, but in eczema of the canal I have found it valuable.

If the affection has become chronic, or if there is considerable infiltration of the skin even in the earlier stages, it is extremely doubtful whether mild measures will prove efficacious in controlling the disease. In such a case our efforts should be directed towards relieving the thickening which results from the cutaneous inflammation. This is perhaps best effected by a brisk friction of the part with green soap once or twice daily, or, as exerting a somewhat less vigorous action, tar soap may be used. After each application an astringent ointment should be applied as before. The green soap frictions are particularly indicated where, in addition to the thickening,

¹ Archiv für Ohrenheilkunde, vol. xvi. p. 60.

² Wiener Medicinische Presse, 1888, No. 18.

³ Zeitschrift für Ohrenheilkunde, vol. x. p. 180.

there is considerable exudation from the surface of the affected part. Where this exudation is not present excellent results may be obtained by painting the area involved with the acetum cantharidis, care being taken not to apply a sufficient quantity of it to blister. If the infiltration is not extensive enough to demand measures of this kind, we may frequently by our applications produce sufficient stimulation to remove a moderate amount of thickening. The oil of cade is as efficacious as any other remedy which can be used. This can be applied in the following manner :

R Ol. cadini, ℥ss;
Cerati simp. q. s. ad ℥j.

Or the ammoniated mercurial ointment may be used in the same manner, either pure or diluted with an equal amount of simple cerate or vaseline. Coincident with these local measures, especially where the disease has existed for a long time, the administration of arsenic internally in increasing doses will do much towards hastening the cure and insuring its permanency.

Pemphigus of the Auricle.—This affection is occasionally observed. Like pemphigus in other portions of the body, the eruption appears in the form of large blebs filled with a clear serous fluid, which may occur upon any part of the external ear. The favorite site, however, seems to be the margin of the helix and of the lobule. Occasionally they are met with on the anterior surface of the auricle, covering this to a greater or less extent. The fluid is ordinarily serous in character, but after persisting for some time, or as the result of minute puncture and subsequent infection or from irritation, may contain a certain number of white blood-corpuscles, rendering it cloudy. It is rarely purulent. After existing for a few days the bullæ rupture spontaneously and the fluid is discharged. If after rupture the wall of the bulla be not destroyed, this may reapply itself to the surface from which it was raised, and may subsequently desquamate in the form of scales, leaving a reddened area, which marks the site of the original eruption. Naturally, if the sac wall is destroyed *in toto* at the time of rupture, an eroded surface is left. This, however, quickly becomes dry, and subsequently presents as a slightly reddened area, marking the site formerly occupied by the bulla. These bullæ appear in crops, and may cease spontaneously or as the result of medication. They are not painful, do not itch, and there is no infiltration of the surrounding skin. The affection is a persistent one, and is more amenable to internal than to local treatment, although it is well to evacuate the fluid contained, by one or two minute punctures in the bulla, and allow its wall to collapse, thus affording a protection to the surface, which would otherwise be denuded. Further protection can be obtained by coating the parts, after puncture, with a thin layer of flexible collodion. The internal treatment consists in the administration of arsenic in gradually increasing doses.

Herpes of the Auricle.—All authors agree that this is one of the rarest of cutaneous affections of the auricle. Cases have been reported, however, by Rohrer,¹ Green,² Chatellier,³ Wagenhäuser,⁴ Gruber,⁵ Bezold,⁶ Burnett,⁷ and others. In most of the cases the affection seems to have been the same, constitutionally, as herpes zoster, differing only in the location of the vesicles. The disease is most likely to attack individuals of a neurotic temperament, and while in some cases the patient has been otherwise in perfect health, we usually expect to find an associated condition of malnutrition, either from improper or insufficient food or from faulty assimilation. Lacharrière⁸ lays especial stress upon the causative relation of affections of the digestive apparatus to this disease. The exciting cause in a majority of instances is an exposure to cold, although any external irritant may excite an attack: thus in Chatellier's case the use of an alcoholic solution of boric acid dropped into the external auditory canal for the relief of a purulent otitis media apparently caused the attack. The affection, without much question, is due to some obscure lesion, probably a neuritis, of the sensory nerves which supply the area attacked. Gruber, in his admirable article upon this subject, states that the principal nerves involved are the auricularis magnus, from the third cervical, and the auriculo-temporal nerve, from the third branch of the trigeminus.

The attack is most frequently attended with marked constitutional symptoms, such as a rise in temperature, acceleration of the pulse, headache, and general malaise. The most characteristic symptom, however, is the intense neuralgic pain, which is not only experienced in the external ear, but may also spread over the side of the face and downward along the neck, following the course of the affected nerves. This pain frequently precedes the appearance of the eruption by several days. The eruption consists of groups of vesicles, rising from a reddish base, and containing at first clear serum, which in time may become turbid or even purulent. The vesicles are usually located in groups, which may later coalesce, forming large bullæ. The eruption ordinarily confines itself to the anterior surface of the auricle, but that this rule is not invariable is shown by Green's case, in which the posterior surface was affected. Ordinarily the cutaneous manifestation is unilateral, but in Wagenhäuser's case it was bilateral. After a few days the vesicles rupture and the affected part desquamates, the site of the vesicles being then marked by small reddish or purplish maculæ. In one case of this kind observed by myself the disease had already reached this stage when the patient came under observation, and a diagnosis could

¹ Bayerischer Intelligenzblatt, 1885, No. 23.

² American Journal of Otology, vol. iii. No. 2.

³ Annales des Maladies de l'Oreille, 1886, No. 6.

⁴ Archiv für Ohrenheilkunde, vol. xxvii. p. 159.

⁵ Monatsschrift für Ohrenheilkunde, May, 1875.

⁶ Archiv für Ohrenheilkunde, vol. xxxii. p. 115.

⁷ A Treatise on the Ear, Philadelphia, 1884, p. 226.

⁸ Archiv für Ohrenheilkunde, vol. xiii. p. 290.

only be made from the clinical history. Occasionally (and this is especially true in cachectic individuals) the disappearance of the vesicles leaves behind eroded or ulcerated areas marking their former site, which sometimes persist for a considerable period of time. The eruption usually confines itself to the auricle, but may extend into the external auditory canal. In Burnett's case the eruption confined itself to the tragus.

The febrile symptoms usually abate, either completely or to a marked degree, upon the appearance of the eruption; yet in Gruber's case they persisted for a considerable period after this appeared. We expect also an abatement of the neuralgic symptoms as soon as the vesicles form, although this is by no means an invariable rule, the neuralgia sometimes persisting through the entire course of the affection, and even for a long time after any trace of the cutaneous manifestation is visible. The affection usually terminates favorably in from one to three weeks, although it may persist for a longer period owing to the appearance of successive crops of vesicles. In patients in whom the nutrition is seriously impaired, and especially in old people, the succeeding ulceration may be somewhat obstinate.

The treatment naturally divides itself into constitutional and local measures. For internal medication a saline purge should be first administered, the diet of the patient carefully watched, and any errors in the habit of life corrected. For the febrile movement, any of the well-known antipyretics, such as antifebrin, antipyrin, or phenacetin, may be used. This latter is especially valuable because it exerts an undoubted influence upon the neuralgia. Any of the above drugs may be given in five-grain doses, repeated hourly until fifteen or twenty grains have been exhibited. Aconitia in doses of one-five-hundredth of a grain, repeated every hour for three or four doses, and subsequently every two hours until the physiological effect of the drug is obtained, will ordinarily control this symptom. Locally, before the appearance of the eruption, the application of cold, by cloths moistened either with ice-water or with cold lead-and-opium solution, is grateful to the patient. After the vesicles have made their appearance the parts may be dusted with some bland powder, such as oxide of zinc, lycopodium, or starch, an effort being made to prevent their early rupture. Another method, recommended by Anstie, is to coat the affected area with collodion. If the vesicles become purulent there is no question that Gruber's recommendation of opening them should be followed. The ulcerations, if any occur, may be treated with iodoform, iodol, or eucrophen, with perhaps occasional stimulation with nitrate of silver. If much pain is experienced, an emollient ointment containing morphine or extract of opium will be beneficial. Counter-irritation over the affected nerves by means of blisters, the actual cautery, or iodine, has been employed without much benefit.

Anstie recommends the administration of morphine hypodermatically over the seat of the affected nerve. It is probable, however, that many patients would object to the injection into the tissues of the face or neck, on account both of the pain and of the possible formation of abscess, with

the resulting disfigurement. The advantages of the method are not so great that we are warranted in urging it.

Syphilis of the Auricle.—The manifestations of this disease are rarely met with upon the external ear, although there is no reason why any of the cutaneous evidences of this affection may not appear in this situation. The primary lesion of syphilis has been found in this locality, as in the instance reported by Zücker.¹ In this case the lesion was located upon the tragus, which was swollen to double its normal size and was of a dark-purplish color, the swelling extending some distance into the external auditory meatus. The submaxillary lymphatic glands and the parotid were somewhat enlarged. The source of the affection in this case was probably a mucous patch.

The erythema of syphilis undoubtedly could be frequently found upon the auricle, provided it were searched for; but as it evidences itself by no symptoms, attention is seldom called to this region during the period of general erythema in a syphilitic patient.

The macular eruption of syphilis is occasionally observed upon the auricle. In a case reported by Rupp² the eruption extended over both auricles, the outer portion of the external auditory canals, and the mastoid region. The cutaneous manifestation appeared during the fifth month after infection. Taylor³ states that it is most frequently found in those parts supported by cartilage.

The papular syphiloderm has been observed in this region by Szenes.⁴ It presents no symptoms of special interest, except that it leaves as a sequel in certain rare cases superficial ulcerations upon the auricle. I have myself observed one case of this character, in a child about a year old, in whom there was an ulceration at the junction of the lobule with the mastoid. The denuded surface measured an inch by an inch and a half, the edges were sharply defined, the surface was scarcely depressed, and there was only a very slight areola. The affection presented so much the appearance of an ordinary intertrigo that for some time I was in doubt as to its exact nature. As it failed to improve, however, the patient was given small doses of calomel internally, followed by the iodide of potassium in increasing doses, and the ulcerated surface was dusted with the powder of calomel. Recovery was prompt and complete. Deprès⁵ reports having observed this lesion upon the lobule. The artificial opening made for an ear-ring formed the starting-point of the ulceration.

A tubercular syphilide is occasionally met with upon the external ear. Sexton⁶ has seen two cases, in one of which there was an ulcer of consid-

¹ Zeitschrift für Ohrenheilkunde, vol. xiii, p. 167.

² Journal of Cutaneous and Genito-Urinary Diseases, October, 1891.

³ Cited by Rupp, loc. cit.

⁴ Archiv für Ohrenheilkunde, vol. xxvi, p. 140.

⁵ Annales des Maladies de l'Oreille, 1878, p. 311.

⁶ Journal of Cutaneous and Venereal Diseases, 1883, p. 257.

erable size on the upper part of the anterior surface of each auricle, near the junction with the cranium. On the right side there was a second ulcer, involving a portion of the tragus, antitragus, and lobule. These ulcerated areas were covered by large crusts, upon the removal of which the characteristic sharply-defined aspect of syphilitic ulceration was seen. In a second case the local morbid condition was unilateral, and was confined to the tragus, the antitragus, and a portion of the concha. Buck,¹ also, has met with examples of this local manifestation of syphilis. In a case observed by the author an ulceration, apparently the result of a tubercular syphilide, was seen upon the auricle of an adult man. The ulceration was about three-quarters of an inch in diameter and was confined to the concha and a portion of the antihelix. The case was seen but once.

Gummata are of somewhat rare occurrence upon the external ear, yet cases have been observed by Hessler,² Burnett,³ Pollak,⁴ and Baratoux.⁵ The gummatous infiltration may be limited in extent and multiple, as in Baratoux's case, or the entire auricle may be infiltrated with the gummatous material, as in the case reported by Hessler. In Burnett's case the tumor first appeared upon the posterior surface of the auricle, while in Pollak's case the deposit was somewhat limited, the resulting ulceration being confined to the upper margin of the helix. Baratoux's case was unique in that there was a multiple deposit. Whether the deposit is confined to one portion of the auricle, or is diffuse and involves the entire external ear, the affected area presents at first as a hard, smooth mass of a deep-red color. In the early stages palpation reveals no evidence of fluid, but later the gumma may soften in the centre, and examination will then reveal deep fluctuation. In case the deposit is localized, there will usually be some slight infiltration of the surrounding tissues. As the process advances, softening becomes more and more marked, and at last the integument covering the deposit breaks down, leaving the characteristic deep ulcer of syphilis.

The treatment of syphilitic lesions of the auricle differs in no respect from that of similar lesions in other portions of the body. If we have to deal with the primary lesion, the parts should be carefully cleansed, and subsequently a little iodoform or eucrophen may be dusted upon the affected area, but aside from this, little or no local treatment is demanded. As soon as the diagnosis is made, the administration of mercury should be begun, under which the lesion must disappear. The erythematous and macular eruptions will scarcely call for local treatment, even if attention should be attracted to them. The superficial ulcerations and the tubercular syphilide simply require cleansing, with perhaps occasional stimulating

¹ American Journal of Otology, 1879.

² Archiv für Ohrenheilkunde, vol. xx. p. 242.

³ A Treatise on the Ear, 2d ed., Philadelphia, 1884, p. 222.

⁴ Allgemeine Wiener Medicinische Zeitung, 1881, No. 20.

⁵ Cited by Rupp, loc. cit.

applications of nitrate of silver, after which the surface of the ulcer may be dusted with iodoform or eucrophen. Constitutional medication should be begun as soon as the diagnosis is made. When we have to deal with a gummatous infiltration we should remember the extreme rapidity with which such deposits may break down, and hence the iodide of potassium should be given in full doses until the desired effect is obtained. If ulceration has not taken place no local treatment will be required. If this has occurred, however, it must be dealt with on general surgical principles. Necrotic tissue must be removed by means of the sharp spoon, and the parts dressed with iodoform or other antiseptic gauze. It is well, however, to postpone any operative procedure until the patient is unquestionably under the influence of the constitutional medication, since, in these cases, parts which we might judge upon inspection to be absolutely beyond hope of repair are frequently restored, and by an early operation such parts would necessarily be removed.

LUPUS OF THE AURICLE.

The cutaneous manifestations designated under the general term of lupus are so manifold that any attempt at more than a very general classification seems to me futile. For convenience, however, we denominate that variety of the affection in which the deposit is superficial as lupus erythematosus, while when the deeper tissues are involved the term lupus vulgaris is used.

Lupus Erythematosus.—Occasionally we find this somewhat rare cutaneous affection involving the auricle primarily; more commonly, however, it attacks the auricle secondarily, spreading from the central portion of the face, which is its favorite starting-point.

It first appears as a sharply-defined red patch upon the affected parts. Beginning as a small, slightly-elevated, deep-red papule, it spreads peripherally; the integument involved becomes thickened, and the color changes to a bright red, the line of demarcation between the normal cutis and the affected portion being rather sharply defined; occasionally small veins are seen in the infiltrated integument; the skin loses its natural pliability, and, owing to the interference with the circulation, the superficial epidermal cells are thrown off rapidly in the form of minute light scales, leaving the surface of the infiltrated areas smooth and glossy: as the affected area increases in size the centre of the patch becomes somewhat depressed and of a lighter color, owing to a slow process of sclerosis in the infiltrated tissue. There is no pain nor itching in the affected part, and the patient is solicitous only on account of the deformity which the affection entails.

In a case observed by the author the affection had involved both auricles in addition to the integument of the face through its entire extent; usually, however, but one auricle is involved.

It is almost impossible to confound lupus erythematosus with any other

cutaneous affection, with the possible exception of eczema. The intense itching of eczema, however, its lighter color, its more rapid progress, and the fact that it usually occurs bilaterally, unless due to some local exciting cause, such as a discharge from the meatus, will ordinarily serve to distinguish it from the affection under consideration, in which the affected area is of a purplish-red color, does not itch, enlarges very slowly, and is usually unilateral.

The local treatment consists in the use of some of the alkaline soaps, such as green soap, the parts being thoroughly rubbed with an aqueous or alcoholic solution of this agent. In this way the infiltration of the integument is reduced by a free outpouring of serum. The denuded surface which results from these frictions is then to be treated by the application of a soothing ointment, such as the ordinary zinc ointment, or the following :

R Bismuthi subnitrat̄is, gr. xx ;
Acidi borici, gr. x ;
Petrolati, ℥ii ;
Unguent. aquæ rosæ, ℥ii.—M.

If this plan is not successful, pyrogallic acid may be applied to the part in the form of an ointment, and in the strength of about one to four or one to eight, or the affected part may be painted with tincture of iodine.

The galvano-cautery, curette, and other radical measures do not succeed here as well as in lupus vulgaris, but may be indicated in certain cases.

Lupus Vulgaris.—Lupus vulgaris, in itself, is one of the rarer diseases met with in dermatological practice, and lupus of the auricle would seem to be an exceedingly rare occurrence, if we are to judge from the reports of cases occurring in otological literature. As these cases present very little practical interest, this may explain the fact that they do not occupy a more prominent place in such reports, as there is no good reason why the external ear should be less frequently attacked by this disease than any other portion of the body. Instances have been reported by Marian,¹ Strawbridge,² Szenes,³ and Bezold.⁴ One case I have observed in one of our city hospitals, the patient, however, not being under my own care, while I have met with one instance in my own hospital practice.

The disease ordinarily presents in its early stages in the form of small, hard nodules, which may appear in any part of the auricle; in Marian's case it was limited to the lobule, while in Szenes's case the helix and scaphoid fossa were involved. In my own case the deposit was limited to the fossa conchæ. The nodules give rise to slight irritation, and are scratched by the patient and very soon become covered with light-brown

¹ Archiv für Ohrenheilkunde, vol. xxv. p. 66.

² Transactions of the American Otological Society, 1878.

³ Archiv für Ohrenheilkunde, vol. xxvi. p. 140.

⁴ Ibid., vol. xxxii. p. 115.

crusts. As the disease progresses the infiltrated areas increase in size and in number. The surface may become ulcerated and suppurating. The inflammatory process extends slowly, and may invade successively a greater or less portion of the auricle. The affected part, in addition to the nodular appearance, becomes coated with brownish crusts, which seldom separate spontaneously. The surrounding parts are reddened and infiltrated, the color being of a deep-purplish hue. When ulceration takes place the loss of substance is small in amount, the erosion proceeds slowly, the edges are not well defined and are not much depressed below the level of the skin, there is no distinct areola, but the margins of the ulcer merge imperceptibly into the diffuse purplish redness of the surrounding parts. A somewhat vigorous effort at spontaneous cicatrization is often observed in lupoid ulcers, and the resultant deformity so often seen is frequently as much due to a subsequent shrinking of the cicatrix as to the primary destruction by the ulcerative process. Although the disease extends very slowly, it does not cease spontaneously, and, unless checked by interference, may ultimately invade the entire auricle, and, spreading along the canal, attack the middle ear. A larger or smaller portion of the external ear may be destroyed by this process. The affection is almost always unilateral.

When seen in its early stages a complete removal of the diseased part is not difficult, and this may be accomplished either by excising the morbid tissue, as was done in Szenes's case, or by applying lactic acid, as was done by Marian. In case this latter remedy is used, the affected area should be first everted with a sharp spoon, after which the acid should be applied to the part by means of a cotton pledget, and thoroughly rubbed into the tissues. In one case which I observed, an attempt was made to eradicate the affection by injections of the tuberculin of Koch. The primary changes set up by these injections were the same as those described by the discoverer of the remedy, in his original paper. The subsequent history of the case I do not know, but, in the light of the experience furnished us by the later experiments with this remedy, I think we should hesitate about advising its employment in any case of lupus of the skin. The same remark applies to Liebreich's solution of cantharidate of potassium. The best method of treating the disease, then, will consist in the thorough use of the sharp spoon. If this fails, lactic acid may be employed in conjunction with it.

WOUNDS AND INJURIES OF THE AURICLE.

Injuries of the auricle are comparatively rare, judging from the number of cases which present themselves in dispensary practice. Incised wounds are of infrequent occurrence, but are occasionally met with. Most frequently we see the resultant deformity of such a traumatism, especially in the case of immigrants coming from those countries where slitting the ears is not an uncommon punishment for petty offences. More rarely the patients are seen a few hours after the injury has been inflicted.

Our chief interest in these cases is the question of treatment. If seen early, the parts should be thoroughly cleansed and the edges brought together by a few points of suture; these sutures should be inserted upon the posterior surface and should pass deeply into the cartilage, but not through the integument upon the anterior surface of the auricle, as the healing process will be attended with less deformity if this method is practised. When seen later, the proper procedure is to freshen the edges of the wound and bring the parts together with sutures in the manner already described in the treatment of incised wounds of the auricle.

Lacerated wounds are more commonly met with. These may result from pulling the ear, as in the case cited by Koll,¹ in which the auricle was detached from the canal posteriorly by pulling the ear violently. Projectiles frequently inflict lacerated wounds upon these parts. Wendt² cites instances in which the auricle has not only been pierced, but also severely lacerated, by bullets. Among the most curious instances on record are the cases reported by Blake³ and Bürkner:⁴ in the former instance the entire auricle was amputated by a wagon passing over it; in the latter case nearly the entire auricle was torn off by a similar accident, but the tragus remained intact, and after the parts had cicatrized fell backward so as completely to close the external auditory canal. I have seen one case in which the entire auricle had been torn off as the result of a traumatism, the patient simply applying for suggestions as to some device for concealing the deformity. The lobule is not infrequently injured by ear-rings being torn out from the ear; the resultant deformity at first glance looks not unlike the congenital condition known as cleft lobule.

The treatment of these injuries consists in thoroughly cleansing the parts, trimming away the lacerated tissue, and, if feasible, uniting the margins of the wound by sutures. If considerable inflammation is found to exist, and this procedure does not seem wise, a moist, cold antiseptic dressing, applied for a day or two, will ordinarily remove the inflammatory condition, when the procedure already indicated may be carried out.

When the case does not present itself until a long time after the accident, our endeavors should be directed towards relieving the deformity by some plastic operation.

The most common injury of the external ear which we are called upon to treat is that resulting from a blow upon the auricle, giving rise to a contused wound of the part. Such a contusion may result either in a hæmatoma or an acute or a chronic perichondritis, with or without fracture of the cartilages. If the traumatism gives rise simply to a hæmatoma, we find the perichondrium lifted from the underlying cartilage, deforming the organ to a greater or less extent and giving rise to a fluctuating tumor

¹ Archiv für Ohrenheilkunde, vol. xxv. p. 76.

² Ibid., vol. iii. p. 32.

³ Ibid., vol. ix. p. 189.

⁴ Ibid., vol. xxii. p. 201.

which more or less completely obliterates the normal contour of the parts. The lobule is not involved in this tumefaction; usually only the anterior surface of the auricle is affected; but Habermann¹ reports a case in which the extravasation was upon the posterior surface. If the cartilages are fractured, we are sometimes able by manipulation to elicit crepitus; the gross appearances, however, do not differ from those of simple hæmatoma. When the injury results in an acute perichondritis also, in addition to the tumefaction above described, the parts are red, hot, and painful on pressure. Upon examining the injured part with the finger, we are able to make out a certain amount of thickening in the perichondrium itself, due to the inflammatory process. This still further increases the tumefaction due to the effusion of blood beneath the perichondrium. In addition to this, the tenderness is more superficial when perichondritis follows such an injury than when the traumatism results in extravasation alone. As a result of such a perichondritis there may be set up a chronic thickening of the perichondrium, resulting in deformity of the parts, as mentioned by Bloch,² who states that such a condition may exist without any previous effusion of fluid. This condition is well illustrated in Fig. 4, in a case observed by the author. In this instance the patient was a professional wrestler and had received many blows upon the ear.

The treatment of contused wounds consists, when seen early, in the application of cold, preferably in the form of lead-and-opium solution, compresses being saturated in this and placed upon the affected part. This may result in a complete disappearance of the effusion, without deformity. If the inflammatory symptoms are severe, however, suppuration may occur; hence if decided amelioration does not follow the application of cold at the end of from twenty-four to forty-eight hours, or if the tumor still persists after the acute symptoms have disappeared, surgical measures must be adopted to dissipate it.

The fluid may be removed by means of an aspirator, and compression subsequently applied, either by placing a pad on the anterior and posterior surfaces of the organ and securing these in position by a firm bandage, or a clamp not unlike a spring clothes-pin may be worn to hold the dressing in position. It will be usually necessary to aspirate the tumor several times, and at best

FIG. 4.



Chronic perichondritis of the auricle.

¹ Archiv für Ohrenheilkunde, vol. xviii. p. 74.

² Zeitschrift für Ohrenheilkunde, vol. xx. p. 53.

the results obtained by this method are unsatisfactory. The best method of treatment consists in incising the tumor along one of the natural folds, evacuating its contents, cleansing the sac thoroughly, scraping any cartilage which may be denuded, and then packing the wound with iodoform gauze and applying a firm bandage. It is scarcely necessary to say that this is the only procedure if suppuration has supervened.

It is sometimes advisable, after incising the tumor in the manner above described and scraping out its contents, to puncture the posterior wall of the auricle through the most dependent portion of the sac and insert a small drainage-tube in this location, the original incision being completely closed by sutures. The resultant deformity may be much reduced by such a procedure.

The effects of heat and those of cold upon the auricle scarcely differ in their manifestations. The extent of the injury done depends, of course, upon the degree to which the tissue is involved. Prolonged exposure to cold, or a severe burn, either by intense heat or by chemical agents, may result in complete or partial necrosis of the part affected. In the large majority of instances, however, which come under observation, the auricle has either been frozen or has suffered from the action of some chemical irritant. In the case of cold, our efforts should first be directed to restoring the circulation by gradually returning the part to its normal temperature, rubbing it briskly first with powdered ice or with snow; after this, some emollient application, such as the ordinary mixture of olive oil and lime-water, or a zinc or lead oxide ointment to which a small amount of extract of opium has been added, will be beneficial. These latter means will be found of service in the relief of burns resulting from either great heat or chemical agents.

INFLAMMATORY AFFECTIONS OF THE AURICLE.

Perichondritis.—Perichondritis, as we have already seen, may follow an injury to this part, particularly a contused wound. The majority of cases, however, which are met with occur either idiopathically or as the result of some inflammatory condition in the external auditory canal. From a clinical point of view, all cases of phlegmonous inflammation of the auricle which persist for any length of time involve the perichondrium, and hence we consider under the term perichondritis, those cases which are sometimes reported in literature as phlegmonous inflammation of the auricle. A true phlegmonous inflammation of the auricle without involvement of the perichondrium must be an exceedingly rare occurrence, and the only point of interest lies in the diagnosis. In perichondritis the inflammatory manifestations involve the entire auricle, with the exception of the lobule, while in phlegmonous inflammation the lobule itself may be involved. A severe inflammation of the perichondrium of the auricle, from any cause, may result in necrosis of the underlying cartilage, the formation of sinuses on the surface of the organ, and considerable resultant deformity. Cases in

which the affection occurred spontaneously have been reported by Benni,¹ Bartsch,² Schwabach,³ Knapp,⁴ and Chimani;⁵ while instances in which the inflammation was secondary to an inflammatory condition of the external auditory meatus are reported by Roosa,⁶ Pooley,⁷ Gruening,⁸ Pomeroy,⁹ and Wendt.¹⁰

When the disease occurs spontaneously, the patient is usually conscious of a feeling of heat, gradually increasing to severe pain, in the auricle, although the discomfort in rare instances may not amount to pain in these early stages. This sensation is quickly followed by an increased vascularity of the part, and very soon by tumefaction, ordinarily most marked upon the anterior surface of the auricle, obliterating, according to its primary seat, either the concha or the scaphoid fossa. The tumefaction may increase uniformly throughout the organ, but usually develops with especial severity at one or more foci, which very soon show evidences of the presence of fluid. Thus, in Schwabach's case the abscess pointed at the antihelix. Meanwhile, the diffuse inflammation of the perichondrium may distort the original contour of the auricle, increasing in a marked degree the dimensions of the antihelix and helix, while the concha is almost entirely obliterated and the tragus and antitragus may completely block the external auditory meatus. Where the affection is secondary to an inflammation of the external auditory canal, we find simply an exaggeration of all the symptoms to which the preceding inflammation has given rise, and subsequently the local condition already described supervenes. The inflammatory process proceeds somewhat rapidly to the formation of abscess, which, if not incised, opens spontaneously. In Bartsch's case there were several openings. A probe introduced into these openings detects exposed necrotic cartilage. In one case under my own observation the perichondritis apparently followed an operation upon the mastoid process. The patient subsequently developed a facial erysipelas, and passed from observation. In a second case the affection was consecutive to a diffuse otitis externa; an abscess formed just below the spine of the helix, and an incision gave vent to a large quantity of pus; the case recovered without deformity in a short time.

The affection in nearly every case is of long duration, and we can seldom promise that a complete cure without deformity can be effected. In a large number of the recorded cases considerable distortion of the parts has persisted after a complete cure of the affection. In the early stages the

¹ *Archiv für Ohrenheilkunde*, vol. xxii. p. 117.

² *Ibid.*, vol. xxii. p. 278.

³ *Deutsche Medicinische Wochenschrift*, 1885, No. 25.

⁴ *Zeitschrift für Ohrenheilkunde*, vol. x. p. 42.

⁵ *Archiv für Ohrenheilkunde*, vol. ii. p. 169.

⁶ *Ibid.*, vol. viii. p. 299.

⁷ *Medical Record*, 1892, vol. xli. p. 148.

⁸ *Archives of Otology*, vol. xix. p. 22.

⁹ *Transactions of the American Otological Society*, 1875.

¹⁰ *Archiv für Ohrenheilkunde*, vol. iii. p. 230.

best method of treatment consists in the application of cold, using for this purpose cloths saturated in ice-water or, perhaps better, in the lead-and-opium solution. If the inflammation does not subside, but evidences of pus-formation appear, an early incision should be made, the parts thoroughly scraped by means of a sharp spoon, the cavity packed with iodo-form gauze, and a firm bandage applied. In Gruening's case a somewhat novel procedure was resorted to. Several linear incisions having been made completely through the auricle from its anterior to its posterior surface, slips of gauze were threaded through these incisions, thus securing perfect drainage. The cure in this case was complete. Gruening¹ believes that in the early stages a perichondritis may be aborted by this procedure and extensive suppuration prevented.

Erysipelas.—An attack of facial erysipelas may involve the cutaneous covering of the auricle in connection with the other cutaneous structures of the face, but occasionally the process may originate in the auricle from the same causes that produce the affection elsewhere. Troeltsch,² however, cites a case which he believes to have been induced by impacted cerumen, while Szenes³ observed an instance in which a wound of the auricle inflicted by a rusty needle seemed to be the cause. I have myself had a case following a perichondritis of the auricle.

The constitutional symptoms are the same as those in erysipelas involving any other portion of the face. Locally, we find the auricle uniformly reddened, the color at first being a bright red, but quickly changing to a hue relatively darker than that exhibited by erysipelas in other portions of the body, and the whole auricle being uniformly involved. This redness disappears upon pressure, but returns immediately. The parts are intensely sensitive to the touch, and the entire auricle is uniformly swollen, so that, although the increase in size is necessarily very small, the ears appear relatively much larger than normal and the delicate outlines of the various parts soon become obliterated. If the condition can be limited to the auricle, the attack may be expected to terminate favorably in a few days. This is frequently impossible, however, and we may usually expect an invasion of all the structures of the face.

The treatment consists in the administration of the ordinary constitutional remedies, notably tincture of the chloride of iron in large doses, together with alcoholic stimulants if such are indicated. Antifebrin or antipyrine may be given to control the temperature. Locally, the parts should be kept constantly moistened with the cold lead-and-opium solution. A cold solution of bichloride of mercury of the strength of one part to three thousand is also serviceable. If these moist applications are contra-indicated for any reason, the auricle may be coated with the following ointment :

¹ Personal communication.

² Archiv für Ohrenheilkunde, vol. vi. p. 48.

³ Ibid., vol. xxvi. p. 140.

R Plumbi oxidi, ʒj;
 Extracti opii, gr. xxv;
 Petrolati q. s. ad ʒj.

Or, in place of the above prescription, Goulard's cerate may be used, to every ounce of which ten or fifteen grains of the extract of opium may be added. The ordinary zinc ointment, with the addition of a small amount of extract of opium for the relief of local pain, also forms a grateful application. Ichthyol, as recommended by Allen,¹ seems to be a drug the local application of which possesses considerable value in the treatment of erysipelas. One of the best ways of applying this is by painting the afflicted part with a ten-per-cent. solution of the drug in flexible collodion. We thus gain, in addition to the local action of the ichthyol, a certain amount of pressure from the contraction of the collodion, resulting in a depletion of the vessels, which may be beneficial, although I am inclined to think that this pressure might be somewhat painful. A five-per-cent. solution of aristol dissolved in collodion is also recommended by Allen, but probably the ichthyol is superior.

In case the collodion causes pain from the pressure which it exerts on drying, the ichthyol or aristol may be incorporated in an ointment of the strength mentioned above, vaseline or simple cerate or cold cream being used as a base.

Abscess.—By this term we designate the small, superficial, and localized cellular inflammations which may be found upon the surface of the auricle, leading to the formation of abscess. These may result from contused wounds, from punctured wounds causing a localized infection of the part, or from the blocking of one of the sebaceous follicles. Any inflammation involving the perichondrium is excluded from this category.

Ordinarily such an inflammation gives rise to very slight local symptoms, and if the resultant abscess does not rupture spontaneously, it is quickly cured by a simple incision. Where abscesses occur in the concha, the inflammation may spread to the external auditory canal and some impairment of hearing may result, as in an instance cited by Bürkner.² Perhaps one of the most frequent locations for inflammations of this kind is in the lobule. I have observed it as the result of piercing the ears for the insertion of ear-rings. In such a case the removal of the foreign body effects a cure without further treatment. In a case cited by Delstanche,³ a portion of an ear-ring had broken off and become encysted in the lobule, giving rise to a phlegmonous inflammation. Its excision relieved the patient of all symptoms.

Thickening of the Lobule.—As the effect of local irritation, chiefly from the wearing of ear-rings, the fibrous framework of the lobule occasionally becomes the seat of an inflammation, hyperplastic in character, which

¹ American Journal of the Medical Sciences, vol. cii. p. 51.

² Archiv für Ohrenheilkunde, vol. xvii. p. 184.

³ Annales des Maladies de l'Oreille, February, 1887.

results in the formation of new connective-tissue fibres in this structure, giving rise to a permanent hypertrophy in this region. Burnett¹ cites an instance of this condition as occurring after an erysipelas of the scalp, and denominates it "glandular hypertrophy of the lobule." In this instance the hypertrophy in the gland-structures seemed to have been preponderant, but there was also some hypertrophy in the connective-tissue elements. Undoubtedly, both the connective tissue and glandular structures in this location may be affected by a chronic inflammation of the parts, and the resultant new tissue thus formed will contain a preponderance of either connective tissue or glandular tissue as the case may be.

The treatment consists in the excision of the hypertrophied portion of the lobule, removing as much tissue as is necessary to reduce the hypertrophied lobule to the size of its fellow upon the opposite side.

Ossification of the Auricle.—We might naturally suppose that a bony deposit in the cartilaginous structures of the auricle would be a somewhat frequent occurrence. Literature, however, furnishes us with very few examples of this condition, instances having been observed by Boehdalek,² Schwabach,³ Linsmayer,⁴ Knapp,⁵ Voltolini,⁶ and Gudden.⁷

The cause of the affection is obscure. In Boehdalek's case malnutrition seems to have been the only prominent factor, while Linsmayer was inclined to attribute the condition in the patient observed by him to the ears having been frozen many years before. In Knapp's case a preceding attack of perichondritis had undoubtedly been the cause of the affection.

The condition is one easily recognized upon examination, the portion of the auricle affected being stiff, inflexible, and board-like to the touch. The bony deposit most frequently takes place in the helix, scaphoid fossa, and antihelix, and in Linsmayer's case it extended upon one side into the floor of the canal. In Knapp's case the antihelix was the part most prominently affected. The affection may be unilateral, as in the case observed by the last-named author, or bilateral, as in the cases observed by Schwabach, Linsmayer, Gudden, and Boehdalek.

The patients may apply for relief from the deformity which exists, but principally on account of the pain caused by the unnatural rigidity of the parts, the pressure caused by the weight of the head on lying upon the side of the face being particularly painful. Knapp dissected out the entire bony growth in the patients who came under his observation, and this would seem to be the only treatment of any value, and should always be done unless the osseous deposit is so extensive as to render this procedure impossible.

¹ A Treatise on the Ear, Philadelphia, 1884, p. 230.

² Prager Vierteljahrschr., 1866, vol. i. p. 33.

³ Deutsche Medicinische Wochenschrift, 1885, No. 25.

⁴ Wiener Klinische Wochenschrift, 1889, No. 12.

⁵ Archives of Otology, vol. xix. p. 45.

⁶ Monatsschrift für Ohrenheilkunde, vol. ii. No. 1.

⁷ Virchow's Archiv, vol. li. p. 457.

Gangrene of the Auricle.—Instances of gangrene of the auricle have been reported by Schwartze,¹ Eitelberg,² Nottingham,³ Boyer,⁴ Riegler,⁵ Moos,⁶ Obre,⁷ and others.

Various causes act to produce the affection under consideration. Schwartze's patient was in an extremely cachectic condition, due to caries of the petrous portion of the temporal bone; while one of Eitelberg's patients was suffering from a profuse purulent otitis media and an intertrigo of the auricle. Eitelberg's second case was one of dry gangrene in a child three weeks old, the auricle being loosened from its attachments below by the gangrenous process. The child was suffering in a marked degree from malnutrition. In Nottingham's case the affection seems to have occurred without any sufficient cause. In the cases reported by Boyer, Obre, Moos, and Riegler, the gangrene was the result of pressure upon the auricle from prolonged rest in the dorsal position during typhus fever, the pressure and the low general condition entailed by the malady both exerting a causative influence upon the affection. Bearing in mind, then, that this affection may be caused by any general condition which tends to lower the vital powers of the patient, especially if combined with this there be continued pressure upon the part, we should naturally expect that any prolonged disease, especially in child-life, might act as an exciting cause of the condition under consideration. In support of this we find both Nottingham⁸ and Bourdillot⁹ citing instances of the affection following measles. Either severe burns or exposure to intense cold may be followed by this condition.

Our treatment should be directed first towards the general condition of the patient. Stimulants should be freely exhibited, the most nutritious diet should be given, and barks and iron should be administered internally. Locally, if the gangrenous process seems to be quite superficial, it may be wise to attempt to destroy it completely by means of the actual cautery or by acids. The parts should be kept warm, to prevent an extension of the process and to favor the formation of a line of demarcation. The best results will be obtained by combating the processes which have caused the local condition, rather than by treatment directed to the local process itself.

Othæmatoma.—The origin of hæmatoma auris occurring without the history of traumatism has been the subject of no little speculation. All authors agree that this condition is found with comparative frequency among the insane, and at a certain period a patient presenting this lesion

¹ Archiv für Ohrenheilkunde, vol. ii. p. 295.

² Wiener Medicinische Wochenschrift, 1885, No. 21.

³ Diseases of the Ear, London, 1857.

⁴ Traité des Maladies Chirurgicales, 1818, tome vi. p. 55.

⁵ D. Türkei, Wien, 1852.

⁶ Archiv für Augen- und Ohrenheilkunde, vol. i. part 2, p. 66.

⁷ Canstatter Jahresbericht, 1844, vol. iv. p. 247.

⁸ Loc. cit.

⁹ Gazette des Hôpitaux, 1868.

without any mental disturbance was looked upon as a curiosity. Numerous authentic reports of this affection as occurring spontaneously in persons of perfectly sound mind have forced upon us the conclusion that the affection is not necessarily an indication of mental disturbance. Cases of this sort have been reported by Wendt,¹ Schwartze,² Weil,³ Howe,⁴ and Wagenhäuser.⁵ No age seems to be exempt from the affection, since in Weil's case the patient was only one and a quarter years old, while Schwartze's patient was a youth of fourteen years.

The affection is ordinarily unilateral, but occasionally we find it bilateral. Thus, Brunner⁶ reports a case in which such a condition appeared first on one side and a year later on the opposite side; in Howe's⁷ case it was also bilateral.

At present we can assign no definite cause for this manifestation. Brown-Séquard⁸ has shown that section of the restiform bodies in dogs will produce a hæmatoma auris, and this undoubtedly has added considerable weight to the clinical fact, already observed, that the affection is frequently met with in patients in whom a cerebral lesion is known to exist. Steinbrügge,⁹ in reporting a case of this affection occurring in a patient possessed of normal mental faculties, states that fifteen years before an injury had been received upon this side, and suggests that many cases of so-called othæmatoma may be the result of injuries long since forgotten. Flesch,¹⁰ on the other hand, from pathological specimens in his possession, attempts to show that certain microscopical changes take place in the auricular cartilage which favor an extravasation of blood. Rudolf¹¹ also believes that in order that a hæmatoma may form there must be a degeneration of cartilage. The pathological condition consists in an effusion of blood between the cartilage of the auricle and the perichondrium, separating this latter from the cartilage. Upon close examination, small plates of cartilage are often found attached to the perichondrium thus separated. Certain observers have attempted to show that these cartilaginous plates were the result of the deposit of new cartilage cells in the separated perichondrium, and were analogous to the bony plates sometimes found in cephalhæmatoma. It is more probable, however, that the plates of cartilage found in these tumors are small fragments which have been torn off by the forcible separation of the perichondrium by the effusion of blood

¹ Archiv für Ohrenheilkunde, vol. iii. p. 29.

² Ibid., vol. ii. p. 213.

³ Monatsschrift für Ohrenheilkunde, 1883, No. 3.

⁴ Transactions of the American Otological Society, vol. iii. part 3.

⁵ Archiv für Ohrenheilkunde, vol. xix. p. 58.

⁶ Ibid., vol. v. p. 26.

⁷ Loc. cit.

⁸ Canstatter Jahresbericht, 1869, vol. ii. p. 27.

⁹ Zeitschrift für Ohrenheilkunde, vol. ix. p. 137.

¹⁰ Archiv für Ohrenheilkunde, vol. xx. p. 291.

¹¹ Internationale Klinische Rundschau, 1888, No. 4.

beneath the perichondrium of the auricle. This is the view adopted by Virchow.¹ Mabile,² on the other hand, states that the effusion is not beneath the perichondrium, but subcutaneous. This observation is not borne out by other investigators. The cause of the changes which favor the subperichondrial extravasation is unknown. Traumatism, as a cause of hæmatoma auris, has already been fully discussed in the section on "Wounds and Injuries of the Auricle."

The tumor appears, as a rule, somewhat suddenly. It may be preceded by a feeling of burning or itching in the affected part, but it is rare for the patient to suffer from any symptoms, either general or local. As the blood is poured out beneath the perichondrium, this latter is dissected up from the cartilage of the auricle. The effusion usually takes place upon the anterior aspect of the organ, and very soon the outlines of the various parts are destroyed and the entire anterior surface of the auricle is occupied by an ovoid tumefaction, palpation of which shows that it contains fluid. The integument covering the tumor is normal in color, or, if the effusion has taken place very rapidly and is large in amount, the surface may be pale from the pressure of the fluid within. The condition is well shown in Fig. 5. In this particular instance the hæmatoma was due to a fall, but the appearances do not differ from those of spontaneous hæmatoma. The maximum size of the tumor is attained somewhat rapidly, and after the effusion has once taken place it does not tend to increase in size, or, if it does, this increase is very slow. The effusion, in the very large majority of cases, takes place upon the anterior surface of the auricle, and Kipp³ states that it always appears in this location. Blau,⁴ however, has seen it appear upon the posterior surface as well.

After the extravasation has taken place it gives rise ordinarily to no symptoms other than those due to the increased size of the part. The tumor may disappear spontaneously, it may rupture, or it may be opened by operative interference; in any case, more or less deformity of the auricle usually remains. Rupture, I am inclined to believe, is somewhat rare, except as the result of a traumatism, and spontaneous absorption occurs so infrequently that we should never, I think, defer operative treatment in the hope that this may take place. The extravasated blood may be drawn

FIG. 5.



Hæmatoma auris.

¹ Pathologie des Tumeurs, Paris, 1869, vol. i. p. 186.

² Archiv für Ohrenheilkunde, vol. xxviii. p. 105.

³ Transactions of the American Otological Society, July 15, 1874.

⁴ Archiv für Ohrenheilkunde, vol. xix. p. 203.

off by means of an aspirator, and pressure applied either by means of firm compresses of cotton placed both in front of and behind the auricle, pressure being exerted by a flannel bandage passed about the head, or by means of small pads of cotton held in place by a properly-constructed clamp. According to Meyer,¹ massage affords one of the best means of treating this condition, and I am inclined to believe that this, together with aspiration, will be found to be one of the most valuable methods of treatment at our disposal. Of course the insertion of a needle into the sac involves the danger of suppuration, and the puncture should be made only under antiseptic precautions, and the wound carefully sealed after puncture. Koll² reports a case in which the incision of such a tumor was followed by suppuration, and necrosis of cartilage. If the cavity refills after aspiration, or if the blood is originally clotted and cannot be removed by this method, or if, after artificial puncture or rupture from any cause, suppuration has supervened, recourse should be had to free incision. Our line of incision should be so directed that it may be partially concealed beneath the margin of the helix, thus deforming the parts as little as possible. When the sac has been freely laid open all clots should be evacuated, and it is well to bear in mind that, although there may be no history of injury, we can never be quite certain that an injury has not taken place; hence necrotic cartilage should be sought for and, if found, removed. If the condition has existed for some time, it is well to scrape the lining walls of the cavity in order to favor their agglutination. The incision can then be sutured through its whole extent, with the exception of the lower angle, into which a few strands of horse-hair are to be inserted for the purpose of drainage, firm pressure applied, and a favorable result confidently expected. Massage after incision is also of undoubted benefit, according to the testimony of Blake.³ Where the tumor has attained considerable size, it is often advisable, after incision and evacuation of the contents in the manner above described, to make a small incision from the most dependent portion of the sac, through the cartilage and integument upon the posterior surface of the auricle. The horse-hair drain is to be inserted through this incision, and the anterior wound then sutured through its entire extent. Recovery after this method of procedure is rapid, and the resultant deformity is less than when the wound is drained anteriorly.

BENIGN TUMORS OF THE AURICLE.

Fibroma.—One of the most common neoplasms found in this region is the fibroid tumor. This growth usually confines itself to the lobule. Race seems to exert a particular influence upon this form of neoplasm. Thus, Saint-Vel⁴ has found it very common among negroes in the Antilles.

¹ Archiv für Ohrenheilkunde, vol. xvi. p. 161.

² Ibid., vol. xxv. p. 77.

³ American Journal of Otology, vol. iii.

⁴ Gazette des Hôpitaux, 1864, No. 84.

Knapp¹ has also called attention to the fact that the negro race is especially liable to be affected with this form of neoplasm. Among the most frequent causes of the growth is the wearing of ear rings, or piercing the ears. In a large number of the cases observed this has been a prominent cause. The growths may attain a large size. Thus, Saint-Vel has seen them as large as a pigeon's egg. The tumor is frequently unilateral, although Finley² and Habermann³ have observed it in both ears. In most instances the tumor is located in the lobule, but cases have been reported by Habermann,⁴ Bürkner,⁵ and Anton⁶ in which it filled the concha, and in Habermann's case it partially occluded the external auditory meatus. The surface of the growth is usually smooth and hard to the touch, but in Habermann's case the surface was nodular. The instance observed by Anton (see Fig. 6) was one of soft fibroma, the fibrous tissue being rich in cells, and there being numerous lymphoid cells scattered among the connective-tissue fibres. Ordinarily these tumors are made up of white fibrous tissue, few cells being present.

The removal of these growths is ordinarily a simple matter, yet Knapp⁷ has called attention to the fact that they are liable to recur, and that by frequent recurrence they may become malignant. In this connection it is interesting to mention the case reported by Holt,⁸ in which simple fibromata of both lobules, after repeated operations, became converted into teratoid growths.

The operative treatment presents no special difficulties. The new formation is circumscribed by the knife, which is made to pierce the entire thickness of the lobule, and is removed, care being taken that the incision passes well into the healthy tissue; the wound is then closed by sutures and heals in a few days. If a considerable portion of the lobule is involved,



Soft fibroma filling the concha. (Anton.)

dissecting out the mass will not be advisable, on account of the redundancy

¹ Archiv für Augen- und Ohrenheilkunde, vol. i. p. 215.

² Philadelphia Medical Times, vol. ix. p. 292.

³ Archiv für Ohrenheilkunde, vol. xvii. p. 29.

⁴ Ibid., vol. xviii. p. 76.

⁵ Ibid., vol. xvi. p. 58.

⁶ Ibid., vol. xxviii. p. 285.

⁷ The Fourth International Otological Congress, Brussels, 1888.

⁸ Transactions of the American Otological Society, July 17, 1883.

of the tissue remaining. If the growth be small, however, it may simply be dissected out and the wound closed by sutures.

In addition to the pure fibromas, we find an instance of fibro-chondroma reported by Strawbridge,¹ occurring in this region, and a case of myxo-fibroma reported by Agnew.² In the former instance the growth resulted from wearing ear-rings, while in Agnew's case the tumor occurred in a cicatrix resulting from the removal of a former fibroid growth. Haug³ has reported a case of lymphangio-fibroma of the tragus, occurring in a child of twelve years. The tumor was almost the size of a cherry, and was attached to the tragus by means of a pedicle. The growth was congenital, and a congenital aural fistula was also present.

Lipoma.—Lipoma does not, so far as I know, occur in the auricle. Bürkner⁴ has reported one case occurring just below the auricle, between the mastoid and the jaw. This was not really a tumor of the auricle, but Kipp⁵ has recorded one instance of fibro-lipoma of the concha. In some places this tumor showed a cavernous structure.

FIG. 7.



Sebaceous tumor of the lobule.

Atheroma.—This neoplasm results from a blocking up of the sebaceous follicles of the integument. By the obstruction of the duct the sebaceous material collects in the acini of the gland, and, not being able to discharge itself, accumulates, forming a cystic tumor of varying size. If the tumor increases rapidly in size it may rupture spontaneously; hence the patient frequently presents himself with a history of recurrent discharge from the growth. The pressure incident upon the increase in size may excite a certain amount of inflammation in the sac, resulting in the formation of pus and a purulent discharge upon rupture. The neoplasm is most frequently located in the lobule, as seen in Fig. 7, or at the junction of the lobule with the integument, as in Fig. 8. In two instances I have observed this latter location, and in both cases the tumor had ruptured spontaneously, suppuration having taken place, and the patients presented a history of "recurrent discharge from behind the ear." A similar history was

observed in a case reported by Kretschmann.⁶ In this case, however, the tumor was located in the lobule, which, as stated above, is a favorite site

¹ Transactions of the American Otological Society, July 21, 1875.

² Ibid., 1878.

³ Archiv für Ohrenheilkunde, vol. xxxii. p. 161.

⁴ Ibid., vol. xvi. p. 68.

⁵ Transactions of the American Otological Society, vol. iii. part 3.

⁶ Archiv für Ohrenheilkunde, vol. xxiii. p. 237.

for its appearance. Marian,¹ however, has observed the growth in the concha. If the tumor has not discharged spontaneously, we ordinarily find a distinct sac to the growth. If, however, spontaneous discharge has taken place, the concurrent inflammation is apt to so amalgamate the sac of the tumor with the surrounding tissues that its recognition is somewhat difficult. The contents of the growth are sebaceous matter, degenerated epithelial cells, and frequently cholesterol crystals.

The treatment consists in enucleating the neoplasm, if possible without rupturing the sac. Where this cannot be done an attempt should be made to dissect out the sac after evacuating its contents. In such cases it is a good procedure to curette the wound thoroughly after the sac has been removed as completely as possible, in order that every vestige of it may be extirpated. In one instance occurring in my own practice, where the growth had recurred many times, this procedure was followed by complete cure. If seen immediately after spontaneous discharge, extirpation is almost impossible. In these instances the free use of the curette and the subsequent thorough application of a concentrated solution of nitrate of silver to the cavity will prove efficient.



FIG. 8.
Sebaceous tumor of the lobule.
(Claiborne.)

Angioma.—This form of growth is seldom met with in the external ear. Instances, however, have been reported by Chimani,² Kipp,³ Jüngken,⁴ Hilton,⁵ and Haug.⁶ Chimani's case was one of cirroid aneurism, which appeared at birth on the left side of the head and subsequently extended upward and backward until it involved the greater part of the left temporal and a portion of the occipital region. At the fifteenth year of age this growth was successfully dissipated by injections of the perchloride of iron. A short time after, however, a similar formation appeared upon the left auricle, and gradually increased in size until, when the patient was nineteen years of age, it involved the entire auricle, being more pronounced upon its posterior surface. The auricle was prominent, displaced from the lateral aspect of the skull, and was of a dark bluish-red color. A distinct murmur could be heard over the growth. Under repeated injections of the perchloride of iron the growth disappeared. Kipp's case was one of cavern-

¹ Archiv für Ohrenheilkunde, vol. xxv. p. 66.

² Ibid., vol. viii. p. 63.

³ Transactions of the American Otological Society, July, 1875.

⁴ Schwartz, Ohrenheilkunde, p. 77.

⁵ Schmidt's Jahrbücher, 1863, vol. cxviii. p. 345.

⁶ Archiv für Ohrenheilkunde, vol. xxxii. p. 158.

ous angioma of the lobule in a man aged fifty. The growth appeared immediately after exposure to severe cold, and gradually increased in size. The tumor was bluish black in color, hemispherical in shape, and, beginning upon the outer side of the lobule, gradually increased in size. It was removed, and the microscope revealed a cavernous structure. Jüngken's case was congenital and terminated fatally from hemorrhage, while the instance cited by Hilton was one of erectile tumor which came on after piercing the ears. Chalons¹ describes an anastomotic aneurism from dilatation of the posterior auricular, occipital, and branches of the superficial ascending cervical arteries. This, of course, would not come under the head of an angioma.

Similar in character to the angiomata are the vascular naevi or ordinary birth-marks which occasionally appear upon the auricle and the integument of the adjacent parts of the neck or face. An instance of the kind is cited by Burnett.² Bozemann³ reports a case of congenital nævus of the left auricle which had attained such dimensions that the part was increased to six times its normal size. Both the temporal and occipital arteries were enormously increased in size.

Patients ordinarily apply for relief on account of the deformity which these growths cause. The treatment will depend somewhat upon the size of the growth. The ordinary port-wine stains may be treated by repeated puncture with the potential cautery, or, in case the vessels involved are larger and the neoplasm presents the form of a circumscribed tumor, it may be excised. The operation should be performed rapidly and the bleeding points subsequently secured. If the growth is limited to the auricle, hemorrhage during the operation can be controlled by the application of a clamp so constructed that upon its application to the part the blood-supply to the growth is shut off. The vessels can then be secured after the excision of the mass. If the growth is larger and extends upon the lateral aspect of the face, head, or neck, the dissection can be carried on with the knife, either slowly, the vessels being divided between two ligatures, or rapidly, the mass being quickly excised and hemorrhage subsequently dealt with, the exact method of procedure depending upon the choice of the operator and upon the location and vascularity of the growth. The method of injection, although affording good results in many cases, would probably not be employed at the present day. The galvano-cautery knife or loop may be serviceable in extirpating growths of this character, but most surgeons will probably rely upon the knife.

Cystoma.—Considerable divergence of opinion exists as to what constitutes a cyst of the auricle. Some authors prefer to include any fluid collection involving a large portion of the auricular surface, and occurring spontaneously, under the term hæmatoma of the auricle; or if there is

¹ Deutsche Klinik, vol. xv.

² Op. cit., p. 228.

³ Schmidt's Jahrbücher, 1869, vol. cxli. p. 325.

a history of traumatism, these cases are frequently called perichondritis, although there may be no signs of inflammation. I agree with Hartmann, however, that certain of these fluid collections present none of the characteristics of perichondritis, and exploratory puncture reveals the fact that they contain simply a reddish serum, and not blood, thus excluding them from the class of hæmatomata. Moreover, incision does not reveal the presence of clots or of fibrin. Exposed cartilage, however, is found upon incision in certain instances. With reference to the origin of these growths, Hessler¹ suggests that the condition may be the result of an injury in early childhood which has been entirely forgotten, and this seems a possible cause. If, however, we admit, as we must do, the occurrence of spontaneous hæmatoma, due probably to degenerative changes in the cartilage, I see no reason why other degenerative changes may not lead to the effusion of serum in this region rather than of blood. To tumors of this description Hartmann² applies the name of cysts of the auricle.

These tumors usually appear upon the anterior surface of the auricle, and in gross appearance resemble somewhat closely a hæmatoma of this region. The tumefaction may be limited in extent, as in Fig. 9, or nearly the entire anterior aspect of the auricle may be involved, the outline of the various parts being almost completely obliterated by the tumor. There is no redness, no tenderness, no history of previous injury. The superficial tenderness and the swelling which are so characteristic of perichondritis are wanting. The fluid collection ordinarily appears quite suddenly, and, having once appeared, shows but little tendency to increase in size. Hessler³ has observed this formation upon the posterior surface of the auricle.

The tumefaction, as a rule, causes no discomfort, and relief is sought simply on account of the deformity. Occasionally contusion of the tumor may set up a perichondritis. Several instances of this form of cyst of the auricle have come under my own observation, and in none of these was there a history of traumatism.

The treatment consists either in the repeated aspiration of the growth, as advised by Seligmann,⁴ or, failing to effect a cure in this manner, in incision and evacuation of the fluid, the cavity being subsequently tamponed

FIG. 9.



Cyst of the auricle.

¹ Archiv für Ohrenheilkunde, vol. xxiii. p. 143.

² Zeitschrift für Ohrenheilkunde, vol. xv. p. 156, vol. xvii. p. 232.

³ Archiv für Ohrenheilkunde, vol. xxv. p. 299.

⁴ Zeitschrift für Ohrenheilkunde, vol. xv. p. 280.

with antiseptic gauze. Fischenisch¹ reports good results from massage of these growths. If aspiration is to be successfully performed, pressure must be made over the affected area, by means either of a properly-constructed clamp or of a bandage, after the fluid has been evacuated.

Injection of the cavity with iodoform and ether I have attempted in one instance, without marked benefit, and aspiration in my hands has not proved as efficacious as a more radical operation. Consequently I believe the best treatment is to incise the sac along one of the natural folds, and, after inserting a few strands of horse-hair or catgut to serve as a drain, to suture the wound. In certain instances it is a better procedure to puncture the cartilage and drain posteriorly, closing the original wound entirely in the manner already described in discussing the treatment of hæmatoma auris. This method has the advantage of allowing the entire anterior incision to heal by first intention, and hence the possibility of any deformity following the treatment is reduced to a minimum. The chances of the fluid collecting a second time are also much less than when posterior drainage is not employed.

Papilloma.—So far as I know, true papillomata do not occur upon the auricle except in the form of warts, which are occasionally found in this locality. Two cases, however, which belong properly to this class of neoplasms have been reported by Buck² under the name of “cornu humanum” of the auricle. In each of these cases there was a hard, dense, horn-like protuberance springing from the upper and posterior portion of the helix. In his first case, which occurred in a male aged fifty-five, the growth started as a small, hard point near the top of the helix, and at the end of two years had attained a length of three-quarters of an inch, while its base was nearly as broad. The rapid increase in size was probably due to harsh methods resorted to by the patient to remove the tumor in its early stages. It was finally excised by Dr. Buck, and complete recovery followed.

MALIGNANT TUMORS OF THE AURICLE.

Carcinoma.—Instances of malignant growths in the external ear have been reported from time to time in aural literature. Any portion of the external ear may be involved in such a growth. In the cases reported by Stacke,³ Schubert,⁴ and Kipp,⁵ the growth involved the concha. Habermann's⁶ case, in addition to involving the external ear, involved the meatus; while in an instance reported by Moos⁷ the growth began in the canal and spread to the auricle, and the same is true of the case reported

¹ Archiv für Ohrenheilkunde, vol. xxv. p. 299.

² A Manual of Diseases of the Ear, New York, 1889, pp. 52 and 53.

³ Archiv für Ohrenheilkunde, vol. xx. p. 270.

⁴ Ibid., vol. xxx. p. 49.

⁵ Transactions of the American Otological Society, vol. iii. part 3.

⁶ Archiv für Ohrenheilkunde, vol. xviii. p. 76.

⁷ Zeitschrift für Ohrenheilkunde, vol. xiii. p. 66.

by Marian.¹ Other instances of carcinoma in this region have been reported by Burnett,² Kretschmann,³ De Rossi,⁴ Seely,⁵ Buck,⁶ Haug,⁷ and others.

The disease ordinarily occurs in patients past middle life, although in Kipp's case the patient was nineteen years of age. The tumor is usually of the epithelial variety of carcinoma, although in Kretschmann's case the growth was reported as an endothelioma. In De Rossi's case the parotid and cervical glands were enlarged, although glandular enlargement is not mentioned in the instances reported by the other authors. In Seely's case the growth was attributed to a rat-bite received six years before. Green⁸ reports the case of a man aged sixty, in whom the disease developed apparently from an eczema which had existed eight months previously. The growth involved the lower part of the right auricle, and subsequently infiltrated the floor of the cartilaginous meatus. There were no enlarged glands, and the excision of the entire auricle, together with a portion of the cartilaginous meatus, seems to have been entirely successful in eradicating the growth. Demarquay⁹ cites an instance of a tumor which appeared as a small wart in the middle of the left helix. This was scratched off, and upon its return it was cauterized with nitric acid. Recurrence again followed, and the new growth, increasing in size, finally involved the entire upper portion of the auricle. Operative interference was declined, and the patient passed from observation.

In the above cases the development of the malignant disease seems to have been rapid, as also in the following case cited by Velpeau.¹⁰ The patient was a man aged sixty-seven, in whom a small growth had appeared two months before at the margin of the tragus. It was first scratched off by the patient, but upon recurrence was cut off by a surgeon. When seen by Velpeau the tumor was larger than during any previous time, was soft, ulcerated, but not bleeding. There was no glandular enlargement. The mass was circumscribed with the knife and removed. It was called a cancrioid or fibro-plastic tumor, although no histological report is given.

These cases are certainly unique, as they developed with great rapidity, while in the other instances cited above the development of the malignant disease was slow.

The affection can scarcely be confounded with any other form of ulcer-

¹ Archiv für Ohrenheilkunde, vol. xxii. p. 212.

² Op. cit., p. 234.

³ Archiv für Ohrenheilkunde, vol. xxiii. p. 237.

⁴ Ibid., vol. xxii. p. 283.

⁵ Transactions of the American Otological Society, 1883, p. 118.

⁶ Op. cit., p. 51.

⁷ Archiv für Ohrenheilkunde, vol. xxxii. p. 164.

⁸ Transactions of the American Otological Society, 1870, p. 62.

⁹ Gazette des Hôpitaux, 1869.

¹⁰ Ibid., 1864, p. 106.

ation or neoplasm in this region, and the gross appearance, together with the history of the case, will usually render the diagnosis clear.

The operative treatment consists in the complete extirpation of the neoplasm, preferably with the knife, although Seely used the galvano-cautery loop with success, amputating the entire auricle. In Green's case a similar operation was performed by means of the knife, hemorrhage being controlled in the usual way. Care must be taken in removing the entire auricle that the external auditory canal be not obliterated during cicatrization. To prevent this the external meatus may be lightly packed with gauze, or a glass or metal plug may be inserted into the canal until the process of cicatrization is complete. In De Rossi's case, in addition to the extirpation of the neoplasm, the parotid and cervical glands were removed, resulting in a complete cure; while in the instance cited by Kipp the neoplasm was removed by means of the curette, and there was no recurrence. If the growth is confined to the external ear and the canal is not involved, the prognosis is certainly not so grave as in malignant disease in other portions of the body, since a complete extirpation by early operation is possible. From the favorable result obtained in De Rossi's case, it would seem that secondary enlargement of the cervical glands does not render the prognosis hopeless, provided radical measures are employed for the complete extirpation of the diseased tissue.

In a case observed by the author the neoplasm apparently originated in the external auditory canal and subsequently involved the base of the antitragus. The tragus was also much thickened, but not ulcerated. The growth in the canal was extirpated through an incision made behind the auricle, this, with the cartilaginous canal, being turned forward and the entire diseased portion of the canal excised, while the infiltration at the base of the antitragus was thoroughly removed by means of the curette. Secondary infiltration of the cervical lymphatics also existed, and this glandular mass was excised. No recurrence took place in the meatus, but four months after the operation a small ulcerated area appeared upon the tragus, and another similar ulceration made its appearance upon the antitragus. The entire auricle was then removed, together with the whole of the cartilaginous canal. Obliteration of the meatus was prevented by the insertion of an aluminium tube. At the present time, nearly four months after the operation, there is no sign of recurrence.

Sarcoma.—Instances of sarcoma in this region have been reported by Roudot¹ and Stacke and Kretschmann,² while Schubert³ cites a case of fibro-sarcoma of the neck which attacked the auricle secondarily. In the case reported by Stacke and Kretschmann the growth involved the pos-

¹ Gazette Médicale de Paris, 1875, No. 26.

² Archiv für Ohrenheilkunde, vol. xxii. p. 261.

³ Ibid., vol. xxx. p. 49.

terior wall of the meatus at its junction with the auricle, and occurred in a male aged thirty-nine. There were no enlarged glands, and the mass was completely extirpated by the galvano-cautery snare and the base of the growth subsequently cauterized by the same instrument. The result was entirely satisfactory. The growth was a spindle-celled sarcoma. In the instance cited by Roudot, the lobule and a portion of the tragus were involved and the growth had existed for twenty years. The entire mass was removed, with apparent success.

ACUTE AND CHRONIC OTITIS EXTERNA, INCLUDING OTOMYCOSIS AND CANCER OF THE AUDITORY CANAL.

BY ROBERT BARCLAY, A.M., M.D.,

Aural Surgeon to St. Mary's Hospital; Consulting Physician in Ear-Diseases in the City Hospital; Consulting Aural Surgeon to the House of the Good Shepherd and to the Henrietta Street Hospital, etc., St. Louis, Missouri.

INFLAMMATION of the external auditory canal may occur in one of three forms: circumscribed, diffuse, and dissecting. It may pass from one form into another, either with or without an interval; or it may occur in two or even all three forms simultaneously.

OTITIS EXTERNA CIRCUMSCRIPTA.

Circumscribed otitis externa is, as its name signifies, a circumscribed inflammation of the external auditory canal. It is commonly termed a boil, furuncle, or phlegmon of the ear.

Varieties.—It may be either what is erroneously termed *idiopathic*; *symptomatic* of diabetes, of general furunculosis, or of an impoverished, a surfeited, a syphilitic, or an over-medicated condition of the general system; or *consequential* to a mechanical or chemical injury of the canal.

Occurrence.—It may occur in any portion of the canal; but, since it arises, as a rule, from the development of pathogenic—more particularly pyogenic—micro-organisms in a gland, and since the glands are more plentiful in the outer third of the canal, this form of inflammation is found more frequently there. It may, however, develop in the bony portion of the canal, which, being lined with very thin tissues, is apt to be involved down to and sometimes into the periosteum. The disease is apt to appear as an epidemic at times; some epidemics being of a mild, others of a severe phase of the disease. The sporadic cases vary widely in severity. There may be but one furuncle produced; but, as a rule, there will be a series of them, in spite of treatment, unless the predisposing factor be discovered and eliminated. With general furunculosis there is apt to be a recurrence of aural furuncles. It is very unusual to find this inflammation at the same stage in both ears; and its simultaneous occurrence in both ears is quite rare. Aural furuncle occurs more frequently as a primary aural disease, although it may follow eczema, otomycosis, tympanic otorrhœa,

or other ear-disease. When occurring symptomatically in diabetes or syphilis, it is more pronounced, less responsive to treatment, and more apt to recur. The disease seems to be most prevalent at the changing seasons of the year, when the hygienic habits of the individual, as well, are most likely to be modified or changed,—particularly in spring. It is not a disease of childhood; is rarely found in the aged; is most frequent in the young adult, or in the mature one who has suffered from want, or—worse than want—surfeit, of the physical “good things of life.” Hence it is most frequent among those at each end of the social scale. In the writer’s experience it seems to have been more common among those whose occupation is a confining or sedentary one.

Etiology.—Its causes may be resolved into predisposing, exciting, and sustaining factors. Now, the tissues of the external auditory canal are subject to the same laws and influences as affect similar structures elsewhere in the body. Anything which interferes with the circulation, nutrition, function, or resistance of the tissues of the external auditory canal may act as a predisposing factor. The general powers—nervous, nutritive, circulatory, and resistant—are more or less affected, not only by the constitutional diseases above mentioned, but also by the character of the patient’s occupation, and environment thereat; by his habits in search of pleasure, recreation, and rest,—particularly as regards the use of beverages, stimulants, narcotics, sedatives, etc.; by previous meddling with the ear itself—by aural instillations of irritating liquids, by picking, scratching, or syringing the ear, or by swabbing it out with aurilaves, coiled towel corners, etc.; by drug-poisoning, as with quinine, salicylic acid, mercury, potassic iodide, calcic sulphide, sodic pyrophosphate, etc.; by reflex irritation from the correlated or the general sympathetic area, from sources such as nasal syringing, surgery, or cautery; the filling of pulpless teeth; the retention and filling of teeth whose dental-pulp canal contains a broken instrument; numerous amalgam or imperfect fillings; mismanagement of concealed or inceptive alveolar abscess; pericementitis, or periostitis; wearing red-rubber or ill-fitting plates or dentures; or other unskilful or objectionable expedient of dentistry. Any of these may induce aural conditions predisposing to circumscribed otitis externa.

Exciting factors in the causation of the disease may not be discovered in every case presenting. But, as a rule, there is discoverable some mechanical, chemical, or atmospheric influence which has been at work in the case. It is said that certain disordered conditions of the digestive apparatus, from ingestion of particular articles of diet, may act thus. However, the gradual diminution of the power of resistance in the tissues of the canal, from any cause, will eventually render the parts an easy prey to pathogenic organisms; and when this power of resistance falls to a point below that of the aggressive micro-organisms, the disease may develop without the intervention of other influence.

The disease, once started, is, as a rule, self-limited, and would not re-

lapse were it not for the persistence of the condition acting as either the predisposing or the exciting factor, which may now be called the sustaining influence.

Pathology.—It begins originally in a gland which has been invaded by pyogenic micro-organisms, and gradually involves the neighboring fibrous and cellular tissues. When this occurs deep within the canal and in the bony meatus, the periosteum is apt to be involved, and the disease is intensely painful and somewhat alarming to an inexperienced medical attendant. Circumscribed suppurative inflammation ensues, and the small abscess, through necrosis and disintegration or rupture of the superjacent tissue, finds exit for its contents, which are pus, and necrotic tissue known as “the core.” Sometimes the boil does not burst; and then it becomes slowly transformed into a fibrous nodule which usually disappears entirely, though it does so very slowly. If the abscess be syphilitic and it should rupture, as it usually does, the edges of the wound soon appear protuberant, ragged, and soft, the discharge being sanious rather than creamy; or the wound may become covered with a dirty-gray scab,—not a real scab, but one composed of desiccated discharges—singularly characteristic of syphilis in this form. Nor will the “core” so readily be discharged then.

After the ordinary wound has discharged sufficiently, the pus-sac heals from the bottom; and a certain amount of induration persists, which, unless there be a recurrence of the furuncle at or very near the same spot, will gradually disappear. Sometimes the inflammation may extend and so become a diffuse otitis externa.

Diagnosis.—There is usually, from the outset of the local pathological process, pain, gradually increasing until sometimes it becomes agonizing. The temperature may be elevated, in some cases very considerably. Sometimes cerebral symptoms develop. These symptoms may recur with the boils, with intervals; or, if the boils recur with very short intervals, the symptoms may seem continuous. With this, as with most forms of otitis externa, there will be local tenderness to pressure, usually so pronounced as to prevent the patient's resting with the affected ear upon the pillow. The more deeply seated the abscess, and the farther from the mouth of the canal, the more pronounced the symptoms. The furuncle of the inner third, or bony portion, of the meatus, involving the periosteum, is extremely painful, and usually attended with great deafness, tinnitus, and autophony.

Inspection of the tissues and parts in the order of their occurrence will show us at once that the lumen of the canal is narrowed, and, instead of being elliptical on transverse section, would be crescentic, through bulging of the affected portion of the canal wall. Care must therefore be taken in introducing the aural speculum that it be small enough and be introduced gently enough to spare the patient unnecessary suffering. The earlier in the disease the bottom of the canal is inspected, the better;—as the drum-head, after swelling of the canal wall, is more or less hidden from view. Careful examination should be made to differentiate this condition from an

extension, through the Rivinian fissure, of inflammation of the malleo-incudal nook—the so-called “dissecting tympano-mastoid abscess.” The early history of the case, and the bulging of the canal wall without that of the membrana flaccida, together with the less opaque and inflamed appearance of the membrana vibrans or tensa, will be something of a guide in making the differentiation. Moreover, in inflammatory middle-ear disease, as a rule, the otacoustic phenomena are from the outset fully as pronounced as the pain, whereas in furuncle of the canal this is not so, since deafness and otacoustic phenomena develop after the disease is well under way. Still, there are exceptions to this to be frequently met with, and extreme care in visual examination in every case will be most likely to avert mistakes. In acute otitis media the membrana tympani will be found intensely congested, opaque, with diminished lustre, and its plane surface sometimes displaced; these, with pronounced subjective symptoms of pain, tinnitus, deafness, autophony, vertigo, etc., might be accepted, nothing contradicting, as evidence of acute otitis media. After the furuncle has ruptured, the discharge will to a certain extent macerate the outer surface of the drum-head, and make it dull, leaden-colored or yellowish, soggy, and indistinct. Removal of the secretions, with careful drying of the parts afterward, will put the drum-head in conditions favorable to a return to the healthy state. It is important to see whether there be any complicating condition, such as a foreign body, cerumen, exostosis, etc.,—anything that could check drainage or interfere with the safe conduct of the case. Foreign bodies and cerumen should be removed, by syringing or instrumental manipulation, with the greatest care.

The exostosis of the canal is not so red, tender, nor painful as the furuncle. Unless an exostosis—if one be found—be so large as to interfere with the growth or drainage of a furuncle, it may be ignored at the time, but subsequently should be removed with the dental surgical engine under anaesthesia. The congenital exostoses are usually bilateral. In any case do not mistake an exostosis for a furuncle, as an operation of incision upon the former would be most unfortunate for all concerned. There is another point which may help in differentiation of furuncle from dissecting tympano-mastoid abscess: with the latter there is apt to be more pain about the scalp and side of the head, and some patients will tell you that their “hair feels sore;” this is not often complained of with furuncles, where usually the pain is confined to the ear or is most intense therein.

Prognosis.—The prognosis as far as life is concerned is excellent; as regards return of hearing, the rule is that even if deafness be profound, hearing will ultimately return. Syphilitic cases, however, are uncertain in prognosis; for the profound deafness may be the result of syphilis, and not of furuncle alone. If the patient be starved or destitute of the necessities of life and health; or if, on the contrary, he has “lived too high;” if he be syphilitic; or diabetic; he is apt to be revisited by furuncles—the furuncles will doubtless be quite severe and prone to recurrence.

Treatment.—Treatment consists in removing the predisposing or sustaining factors ; in allaying, if possible, the local inflammation ; if this be impossible, then in hastening the maturation of the process ; liberating the products of inflammation ; cleansing, disinfecting, and soothing the parts ; hastening resolution ; and allaying the subjective symptoms as far as possible.

First, remove the predisposing cause. Search carefully for sources of reflex irritation, for inflammation and irritation in the correlated sympathetic area and elsewhere. In the early stages we may use opium (Gregory's syrup, Dover's powder), mercury, sulphide of calcium, and pyrophosphate of sodium freely in small and frequently-repeated doses. Keep the patient's bowels open with calomel or concentrated saline solutions. Reduce temperature with aconite, antipyrin, acetanilide, or phenacetin. It has been advised by some to inject carbolized oil into the inflamed spot, or to make local applications to the inflamed spot with yellow oxide of mercury gr. ii or more to ʒj of simple cerate ; or with oleate of mercury, ten per cent. Any good mercurial ointment will be of service. Or apply some strong caustic,—nitrate of silver, for example. Some authorities advise the use of water as hot as can be borne without pain, by either irrigation or instillation, changing the water whenever it loses its heat. In this manner heat and moisture—the essentials of a poultice—may be applied, and so hasten suppuration. Laudanum may be added to the water. The writer, however, believes that this tends to maceration of the tissues, and that until maturation seems inevitable, it should not be employed. However, it is highly recommended by eminent authorities ; and may sometimes reduce the patient's discomfort.

Local abstraction of blood about the meatus is still preferred by some ; but is worse than useless. Cases of poisoning from leech-bite, of a leech crawling into the meatus, etc., have been reported. If local abstraction of blood be deemed advisable, and from near the meatus, it is better to take it by wet cupping, with, for instance, Bacon's artificial leech. A better way, however, is to take the blood right from the inflamed spot—the furuncle itself, where tension is greatest. The resort to the knife as soon as it is evident that the furuncle has “gathered” is advisable. A bold incision of the furuncle to its very bottom will afford subsequent relief to the suffering patient. For the performance of this operation at the mouth of the meatus any knife will do whose blade is so shaped that it can enter the furuncle properly ; but the best, and for the furuncle of the osseous meatus the only, knife is one of three,—Buck's (Fig. 1), Politzer's (Fig. 2), and Sexton's (Fig. 3). Those who prefer a blade-shank at an obtuse angle to the handle will find Sexton's most satisfactory. If a straight one be preferred, Politzer's or Buck's will answer better. After liberation of pus and other inflammatory products, the parts should be thoroughly cleansed by syringing, and dressed antiseptically at intervals. An alkaline wash of borax or bicarbonate of sodium and warm water (gr. x or xx to fʒj) is best for preliminary softening and loosening of crusts of discharge.

As a soothing measure, it is well, using a camel's-hair brush, to paint the walls of the meatus with some emollient ointment, such as cold cream, or

R Hydrarg. ammoniati, gr. i-ii;

Ungt. aq. rosæ, ℥j.

M. et ft. ung.

Sig.—Apply to the ear with a camel's-hair pencil.¹

Before the furuncle is inevitably formed, belladonna ointment, carbolic acid, pyoktanin (Merck) ("methyl violet"), iodine and iodide of potassium, nitrate of silver, menthol, salicylic acid, and many other materia medica have, in combination with a suitable vehicle, each proved of service in certain individual cases. No fixed rule for treatment can be formulated. Each case should be carefully examined and then treated on its merits.

If granulations remain after the furuncle is otherwise closed, either curette them or, with small cotton dossil, cauterize with nitrate of silver, or dress with powdered boric acid or pyoktanin or alcohol; rather than instil medicine which would affect the entire canal and drum-head.

If the patient be syphilitic, the sores in the ear are to be treated, as far as possible, as such lesions in syphilis are treated elsewhere. Otherwise, proceed as advised above. If the granulations grow so extensively as to form polypi, they are to be treated as advised under Otitis Media Purulenta Chronica and its Complications (*q. v.*).

Internal alterative treatment is indicated, to prevent recurrence of the furuncle; and if syphilis or diabetes complicate the case, appropriate treatment therefor should be pursued from the outset. Among

internal remedies for furuncle most highly esteemed are iron, quinine,

FIG. 3.

FIG. 2.

FIG. 1.

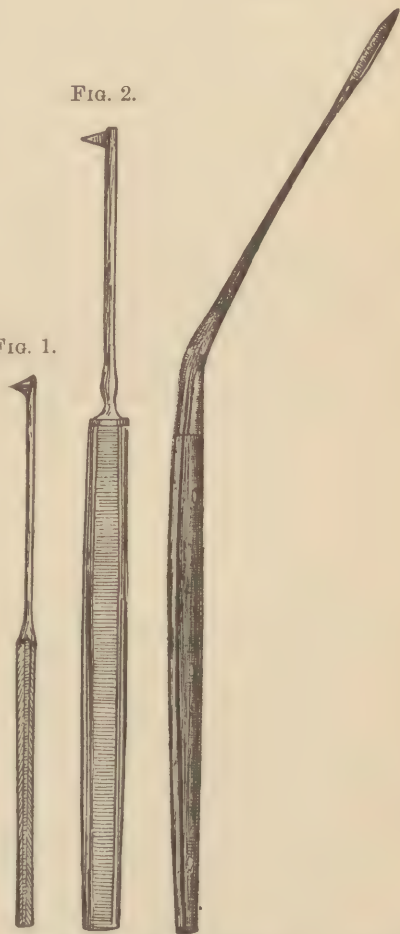


Fig. 1, Buck's furuncle knife; Fig. 2, Politzer's meatus knife; Fig. 3, Sexton's membrana-flaccida knife, for free incision of membrana flaccida or canal wall.

¹ C. H. Burnett, *The Ear*, Philadelphia, 1884, p. 250.

arsenic, calcic sulphide, the malt liquors, hot baths, and a liberal and nutritious diet. In diabetes mellitus the phosphide of calcium (gr. $\frac{1}{10}$ to $\frac{1}{2}$ at a dose) should be thought of.¹ Cod-liver oil is often of service in conditions of malnutrition.

OTITIS EXTERNA DIFFUSA.

This is an inflammation of the tissues of the external auditory canal, persistently tending to extend and involve the entire organ. Though usually developed in the inner or osseous portion of the meatus, it is not always so. Neither does it, in different cases, always begin in the same tissue; nor in any given case necessarily confine its operation to one tissue or any particular group of tissues—which is quite explicable through the structure and intimate relationship of the tissues of the canal. The special relation of the skin to the periosteum, and their attachment to each other, stronger than that of periosteum to the underlying bone, readily account for the easy extension of inflammation from the surface to the bone, for the frequent formation of dissecting inflammation following otitis media, and for the comparative ease with which it may travel to the temporal, mastoid, or cervical region.

Varieties.—Diffuse otitis externa may be, in nature, either simple, diphtheritic or croupous, gangrenous, syphilitic, cancerous, or parasitic.

Occurrence.—It may be primary; or it may be secondary to inflammation of the auricle, mastoid process, tympanum, parotid gland, or other contiguous structure. It may be a local manifestation of a morbid constitutional condition, such as debility or malnutrition, scrofula, diphtheria, or syphilis; may arise from the encroachment of macro- or micro-organisms, animal or vegetable; or it may be the primary nidus of a fatal cancerous metamorphosis.

Etiology.—The causes of diffuse otitis externa are, first, those predisposing conditions characterized by diminished power of resistance in the tissues: vaso-motor paresis, tropho-neuroses, secretory disturbance, and similar conditions of disorder and disease; next, certain constitutional conditions: general debility, malnutrition, any abnormal state of the blood, scrofula, the exanthemata, diphtheria, syphilis, the cancerous diathesis; any traumatic agency, cold or heat, wounds, injuries, irritation,—mechanical, chemical, thermal,—or previous furuncular, eczematous, or other disease of the canal.

Diagnosis.—The symptoms of this disease, while resembling those of the circumscribed variety of external otitis, are far more pronounced and more distressing to the patient; it being the rule that when this is a secondary process, especially when following otitis media purulenta, the symptoms are more moderate in severity. A distinction here not to be overlooked is that between diffuse otitis externa following otitis media purulenta and the dis-

¹ F. A. Packard, Hare's System of Practical Therapeutics, vol. i. p. 1033, Philadelphia, 1892.

secting abscess of the canal from middle-ear disease, for in the latter, pain may be intense and even excruciating until tension has been relieved.

As said above, deafness, tinnitus, and pain are more pronounced and more obstinate here than with the circumscribed otitis externa; pain being especially severe and constant in that diphtheritic form where the characteristic false membrane forms on the surface, at the stage where the membrane is forming; the disease in syphilitics being less painful. The preliminary stage of congestion, like surface inflammation generally at the same stage, is apt to induce decided itching, less irritating than that induced by circumscribed otitis externa. As one might anticipate, the pain attending the inflammation of the superficial tissues (cancer excepted) is not as great as that involving the deeper ones, more especially the periosteum, which is, as a rule, very intense. Symptoms local elsewhere or general, characteristic of the constitutional affection, may coexist in diphtheritic or croupous, syphilitic, scrofulous, or cancerous diffuse otitis externa. In the very painful or acute stage of the disease there is usually fever of variable altitude, which is apt to be increased just before exfoliation occurs, or at any other time when therapeutic procedures prove painful or irritating. Other symptoms of the sthenic type—such as full and rapid, bounding pulse, intense anxiety and restlessness, with anorexia, and pain of various kinds—may attend the inflammation at its active stage.

The so-called simple, diphtheritic, gangrenous, syphilitic, cancerous, and parasitic otitis externa have physical signs dissimilar in some respects. Let us give attention to the general features as found in the simple otitis externa diffusa, and then pass to those points of interest peculiar to each variety of diffuse inflammation of the canal.

Simple diffuse otitis externa may give no physical sign other than that of a simple erythema of the surface tissue. In the typical case, however, the inflammation develops rapidly, the skin of the canal becomes intensely reddened and swollen, and the lumen of the canal consequently diminished, which, as the inflammation persists, decreases more and more until, in some cases, the canal is closed. This occurs the more rapidly from the fact that the different parts or longitudinal folds of the swollen canal are apposed to each other or to the rest of the canal, thus shutting up its lumen.

This disease is seen most frequently in the osseous canal and near the fundus; and the attendant swelling is usually greater upon the posterior canal wall near the *membrana flaccida*. Inasmuch as the swelling takes place at the expense of the corresponding calibre of the canal, the view of the drum-head, as the inflammation increases, is cut off more and more. The appearances of the drum-head before this condition is reached are, first, congestion of the myringal plexus of blood-vessels, dulness, opacity, and flattening of the drum-head, and fusion of the canal wall with the *membrana tympani* at the posterior and superior edges. When the deeper tissues are involved, the swelling may be so great as to obliterate the calibre of the canal, and although the skin be dry and smooth, the smallest

speculum cannot be introduced. In such cases we may find tenderness about the temporo-maxillary notch, of the jaw, the mastoid, and the intervening cervical region, with pain on moving the jaw. Careful examination will discover the nature of such local inflammation, which is frequently glandular. There is finally a discharge, sero-sanguinolent at first, sero-purulent later, which escapes from one, sometimes more than one, opening. The superficial tissues are apt to exfoliate; and then the portions of epidermis coming away leave the canal wall excoriated and coated with discharge. Sometimes a portion of the outer layer of the drum-head exfoliates, and not infrequently the drum-head is perforated in consequence, when purulent otorrhœa may ensue. Care is enjoined in the use of the syringe or cotton-wool dossils, lest this accident be hastened.

In case the drum-head cannot be seen, we have otacoustic tests to determine whether or not there be otitis media: the various methods of tympanic inflation—Valsalva's, Politzer's, Gruber's—to determine the pneumatic condition of the cavum tympani and the permeability of the Eustachian tube; tests of audition; and examination of the pharyngeal orifice of the Eustachian tube. In this disease, granulations and polypi of considerable size, mostly fibroma (if from the wall of the canal), may form.

Prognosis.—The process may go on to resolution and cure, with or without slight stenosis or stricture of the lumen, which may subsequently disappear; with formation of bands, membranous or osseous septa; or, instead, it may extend to other parts, sometimes resulting fatally.

These are the usual features of simple diffuse otitis externa. In the specific or complicated varieties of the disease, however, subjective symptoms and physical signs present great diversity, not only in the different varieties, but in different individuals affected with the same variety of diffuse otitis externa. These special features, together with certain peculiarities, and, particularly, modifications of treatment of each, demand separate consideration, and are therefore placed apart under the several captions Otitis Externa Diffusa Diphtheritica *scu* Crouposa, Otitis Externa Diffusa Gangrænosa, Otitis Externa Diffusa Syphilitica, Otitis Externa Diffusa Maligna, and Otitis Externa Diffusa Parasitica.

Treatment.—Let us consider first the treatment of simple diffuse otitis externa. In the early stages of this inflammation we may apply locally heat and moisture,—the essentials of the poultice. An irrigating douche of water as hot as the patient finds tolerable, or frequent instillations of this hot water into the upturned ear, repeated as proves pleasant to the patient, will accomplish this. This water may be medicated with anodynes,—morphina, laudanum, atropina, carbolic acid, menthol,—or with alcohol.

R Morphinæ sulphatis, gr. iv;

Aquæ,¹ fʒij.—M.

Sig.—Ten drops, warm, in ear, as required.

¹ "For water, cherry-laurel water may be substituted." (C. H. Burnett.)

R Atropinæ sulph., gr. j;
Aquæ destillat., ℥j.—M.

Sig.—Five drops, warm, in ear, as required. (S. Theobald.)

Absolute alcohol, instilled into the ear, is said to abort the inflammation and reduce the pain.¹ (Voltolini and Weber-Liel.)

The "domestic remedies" so-called—onions, fat, oil, etc.—are contraindicated, inasmuch as they are not only harmful or, at best, inert, but favor the development of aural fungi and its attendant disease. (See Otitis Externa Parasitica.)

If the patient be seen early in the disease, before exudation has occurred, it will be well to give him calomel and sodium bicarbonate (gr. $\frac{1}{3}$ of the former to gr. ij of the latter) every two hours up to six doses, when a dose of Carlsbad water or other non-acid saline should be given. If fever be high at this stage, give tincture of veratrum viride, or tincture of aconite in small and frequently-repeated doses. The aconite seems, when thus administered in this disease, to be quite effective as an anodyne. We may give instead extract of aconite gr. $\frac{1}{10}$ every two hours.

Sulphide of calcium (gr. $\frac{1}{10}$ every four hours or gr. $\frac{1}{20}$ every hour) may be given to adults.² Pyrophosphate of sodium, according to Theobald, is quite valuable in this condition, and may be given in doses of gr. x to xx every two or more hours, according to the urgency of the symptoms.³ Doses of Dover's powder, a cathartic, or small doses of mercury (mild chloride or protiodide) may prove serviceable. It may be said here that mercury so used tends to reduce the plasticity of the blood and check fibrinous exudation.

If these measures fail to check the inflammation, local depletion, or else bleeding into other blood-vessels (as by tincture of veratrum viride), should be tried. Leeching is recommended still by some; but is not only ineffectual, as a rule, but may irritate; and even poisoning from a leech-bite has been reported. A better method of depletion is to incise the over-distended part. Examination by light reflected from the forehead-mirror will show the spot most swollen and reddened. The probe should not be used to discover the seat of greatest inflammation. It is here that a bold incision clear to the bone is so often followed by relief of pain and by improvement. In making this incision the furuncle knife of Buck (Fig. 1), the meatus knife of Politzer (Fig. 2), or the membrana-flaccida knife of Sexton (Fig. 3) may be used at choice.

It is hardly necessary to remark that the pungent adage "tender surgeons make ghastly wounds"—"ghastly" *i.e.*, from the stand-point of practical therapeutics—applies here, for an insufficient incision is worse than none, and will surely aggravate the inflammation. The operator, therefore, should determine by sight alone the point which by swelling and redness

¹ Monatsschrift für Ohrenheilkunde, 1877, No. 7.

² See S. Sexton, Transactions of the American Otological Society, 1879.

³ S. Theobald, Philadelphia Medical News, February, 1882.

seems the seat of greatest intensity of the inflammation, and should then cut freely and deeply, clear down to the bone, being careful to start the cut sufficiently far within the meatus to include the entire swelling on the drum-head side. A thorough cut, thus, may give prompt relief and avert suppuration. But sometimes all efforts will be unavailing to check the progress of the disease, and an aural discharge may begin. The discharge peculiar to this disease is at first thin and reddish,—sanious, and quite profuse. The tissue of the canal from which it flows is particularly tender and irritable and extremely intolerant of any irritant or stimulant. For this reason the very gentlest methods of cleansing must be employed. Mild syringing with warm water medicated with Castile soap, bicarbonate of sodium, table-salt, borax, or boric acid may cleanse with impunity. Be careful in using the cotton-wool brush. It is apt to irritate unless used skilfully and *working always towards the outlet* of the canal and without undue pressure upon the parts.

From sero-sanguinolent, the discharge may become sero-purulent in character, and later somewhat thick, more difficult to remove, and at the same time more irritating. It is one of the prime factors in the production of granulation tissue of the inflamed canal wall. When this begins to form it is imperative upon us to keep the parts scrupulously clean and repress the granulations. Dr. Charles H. Burnett¹ advises the method of aspiration, with the Siegle pneumatic speculum, of the air in the canal. Rarefying the air in the canal brings forth the pus from the sores and the subdermal abscesses, and induces a capillary hemorrhagic oozing from the denuded, fissured, or excoriated portions of the canal. This not only cleanses, but stimulates.

The best method of treatment by far is that with remedies in the form of powder (impalpable) or alcoholic solution. Of the best powders we may mention boric acid; boric acid and tincture of calendula officinalis, equal parts, evaporated to dryness, and finely triturated;² salicylate of chinoline and boric acid, one part of the former to sixteen parts of the latter;³ boric acid and zinc oxide, equal parts;⁴ resorcin and boric acid, one part of the former to eight parts of the latter; and methyl violet (pyoktanin cœruleum). These should be used sparingly,—rarely so profusely as to exceed the dissolving capacity of the discharge expected before the next dressing, which should, where discharge is very copious, be made at intervals sufficiently short to insure the constant presence of some of the powder in the canal. Pouring or packing the powder into the canal, or insufflating it, without discrimination as regards its amount and lodgement within the canal, is as unreasonable as it is inapplicable and ineffectual, and the medical practitioner should not use the remedy thus. The best way, for ordi-

¹ A Practical Treatise on the Ear and its Diseases, Philadelphia, 1884, pp. 259 and 260.

² Samuel Sexton.

³ Charles H. Burnett.

⁴ Samuel Theobald.

nary purposes, is to insert into a black-rubber flexible tube a cylinder several inches long made from an ordinary goose-quill tooth-pick. The free end of the rubber tubing can be held in the mouth of the operator; the other dipped into a shallow dishful of the powder, which will partially fill or load the instrument; and then the quill can be aimed at the desired spot, when a slight puff of breath through the tube will deposit the powder there. The use of dry preparations (powders) reduces the moisture present to a minimum and tends to retard or destroy the growth of granulations. Should they develop notwithstanding, they may be restrained by touching with a bead of nitrate of silver fused on the end of a silver probe, or with a small cotton-wool brush carrying a saturated solution of nitrate of silver. Alcohol concentrated as far as the patient can endure it is an efficient agent against these redundant growths. It is in a large measure entitled to the credit for the curative property of many compounds containing it,—such as, for example, solutions of laudanum.

Of liquid remedies we may use solutions of alcohol, of borax, of boric acid to saturation, of sulphate of zinc (gr. i to 3i); of methyl violet (C.P.) (pyoktanin cœruleum), one to one thousand or two thousand, etc.

The solution should be quite warm, and then dropped, or, if discharge is profuse, syringed into the ear once or twice daily. The syringing should be done here, as in similar conditions elsewhere, by the physician or his trained assistant; otherwise harm may be done.

The writer advises the use, preferably, of powders where the diseased tissues of the ear already afford a fluid discharge sufficient to dissolve them; thus lessening the factors predisposing to the formation of polypi. If polypi form, they should be removed, after having been shrivelled as far as possible with desiccating and coagulating remedies. After removal, their base should be curetted, if necessary, and then devitalized by cautery, acid, or other suitable means. (For full particulars on the treatment of polypi, see special chapter thereupon.)

General treatment, hygiene, tonics, etc., should be employed where indicated, and it will of course occur to the medical attendant to ascertain the existence and character of any predisposing or sustaining factor and then to remove it, if this be possible; or, if it be not so, to ameliorate it to the utmost of his skill.

To learn the management of the different varieties of diffuse otitis externa, we will doubtless find it most profitable to study it in connection with the different varieties as if they were independent and dissimilar diseases. Let us, then, consider separately the different varieties as follows:

OTITIS EXTERNA DISSECANS.

Although not customarily mentioned among the diseases of the external auditory canal, still otitis externa dissecans is one, an important one, and one for introducing which the writer trusts an ample apology may be found in the importance of the subject itself.

This is an inflammation neither circumscribed nor diffuse, but dissecting in the walls of the external auditory canal. Now, by the first of these terms is meant an inflammation which is, generally speaking, circumscribed, tending to concentrate at some point of the canal; by the second, one which is diffuse, with a tendency to spread to all parts of the canal; but by the third, one which, unlike either of these, enters the canal by dissecting its tissues, passing along in them through and out of the canal without destroying its wall, and finding its outlet, ultimately, through some outside superficial tissue relatively distant from the source of the inflammation.

Varieties.—It may be said that there are several varieties of this disease. Considered in respect to the progress it has made within the canal, we may say two: one, where the dissection of the tissues by the abscess has just begun; the other, where the dissection has been completed, the abscess having passed through, out of, and beyond the canal. The latter may be further subdivided into the tympano-mastoid, tympano-temporal, and tympano-cervical abscesses,—according to the region invaded by it on exit from the canal. The tympano-mastoid occurs most frequently; the tympano-temporal is infrequent; while the tympano-cervical is extremely rare.

Occurrence.—This disease may occur during an attack, or as a complication, of otitis media, acute or chronic, attended with the formation of secretions in the tympanic attic, petro-mastoid antrum, or malleo-incudal nook, where the secretions are so abundantly forming that they do not find exit through the tympanum below and the membrana tympani.

Etiology.—The conditions leading to the development of this disease are those which produce acute otitis media, or an exacerbation of chronic otitis media, with rapid increase of secretions in the tympanic attic, so copious as to find escape through the tympanic atrium, tegmen tympani, or mastoid cells and cortex more difficult than through the Rivinian fissure by dissection into the tissues of the canal wall (on the posterior superior side, as a rule). The extension of the dissecting abscess arises from this fact: the soft tissues of the canal being so much more intimately connected with the periosteum than the periosteum is with the bone beneath, the inflammation finds it less difficult to dissect along in, than to perforate and escape from, the tissues of the canal. Furthermore there are often bands and septa in the tympanum which separate atrium and attic, preventing escape of secretions through the atrium and the membrana tympani vibrans.¹

Pathology.—The inflammation, by extension, attacks the periosteum of the inferior surface of the auditory plate, the thin shelf of bone at the inner end of the upper canal wall bridging the Rivinian fissure, opposite the malleo-incudal surface, underlying the membrana flaccida of the drum-head. Instead of giving way by rupture, as the secretions press upon it, the membrana flaccida, for the reason above explained, separates, as a rule,

¹ C. J. Blake, Archives of Otology, 1891.

from its attached auditory plate or process, and sags downward, thus forming a pendulous cul-de-sac of secretions. As the amount of secretion increases, the periosteum is stripped off farther and farther, usually along the posterior superior canal wall. The process continuing, the abscess finally dissects into the mastoid, temporal, cervical, or other outer region, where the surgeon, on discovering evidence of its presence, liberates it. The disease seems to have a tendency to involve a longitudinal strip of the wall of the canal, as broad only as is necessary to give passage, by dissection, to the increasing fluid product of the abscess, thereby giving more room thereto and reducing tension from pent-up secretions. The abscess rarely opens spontaneously through the wall into the lumen of the canal, but pursues its peculiar course as a dissecting abscess of the canal, usually opening without.

Diagnosis.—The disease may be recognized by evidence of existing acute middle-ear disease or by an exacerbation of chronic otitis media; by aural neuralgia intense and persistent, worse at night; and by pains on the corresponding side of the head, especially of a portion of the scalp, which is somewhat tender to slight touch, not to pressure, and, as an ingenious patient described it to the writer, the “hair feels sore.” If the abscess be dissecting along the posterior superior canal wall, the “hair feels sore” more especially over the parieto-vertical region; if along the anterior superior canal wall, the tenderness and pain will be greatest at the fronto-temporal or fronto-parietal or parieto-temporal region; if lower down in the canal wall, the pain is often correspondingly lower. This respects, of course, only the pain due to the dissecting abscess and periostitis of the canal wall. With the meningeal neuralgia of middle-ear disease, and with the phenomena of pachymeningitis, etc., therefrom resultant, this symptom has no connection, and inspection of the fundus of the canal and touching the scalp or hair lightly will assist in preventing one’s mistaking them therefor,—an oversight or error that might induce the physician to attempt a very difficult and dangerous operation for “symptoms that ‘threaten life,’”¹ thereby unnecessarily imposing a capital risk upon the patient, when, in fact, life is not endangered so far as these symptoms indicate, and when a simple operation within the canal is the only surgical procedure permissible under the circumstances.

Inspection of the canal and drum-head with light reflected from the concave forehead-mirror² will discover the highly-inflamed or bulging membrana flaccida, frequently sagging downward, sometimes drooping so low as to cut off almost all view of the drum-head. The pain is intense, not only in the ear, but over the scalp of the corresponding side, out of all proportion to the deafness and other otacoustic disturbance,—as is usually

¹ S. Sexton, *The Ear and its Diseases*, New York, 1888, p. 283.

² In inspecting, and when operating in the deeper parts of the canal, always use the peep-sight, or central opening, of the concave forehead-mirror, as you thereby have light most abundant upon and more directly reflected from the object illuminated and so obtain maximum sight.

the case where the nidus of the inflammation is in the malleo-incudal niche. The situation of the abscess is, at the outset, usually at the posterior superior portion of the canal wall at its junction with the membrana flaccida, and is easily seen. If, however, it dissect in the anterior superior canal wall, the swelling can be not quite so easily recognized and inspected.

If the disease has extended until the abscess has dissected throughout the canal, the lumen of the canal will be narrowed at the expense of the affected side. Redness, heat, tenderness, swelling, and, later, fluctuation over the invaded region outside the canal, continuous with that within, characterize another phase of the disease.

The intense pain, deafness, tinnitus, autophony, vertigo, meningeal neuralgia, and other symptoms of severe otitis media, taken together, though characteristic in the early stage of this form of external otitis, are comparatively rare in that of most others.

Prognosis.—Inasmuch as this disease develops in connection with aggressive and serious inflammation of the attic of the tympanum, with pent-up secretions, our chances of cure depend almost wholly upon our ability to establish and maintain satisfactory drainage from this region while building up our patient's general health. So far as the writer knows, these cases never die of the otitis externa directly, though a neglect to take advantage of the opportunities here presented may indirectly lead to a fatal result. The original tympanic and mastoid disease is in these cases very properly a source of anxiety to the practitioner; for it is, as a rule, from that region—the original seat of the inflammation—that we find the destructive process extend to vital parts, causing death. In brief, the prognosis as regards final recovery is good, under proper treatment; but depends largely upon recognition, appreciation, and management of this concomitant feature of the case.

Treatment.—The writer does not approve of prolonged douching of the canal with warm or hot solutions. The parts should be cleansed once with an antiseptic solution, and then operated upon without delay, for delay is dangerous, and the disease may meanwhile extend to vital parts. In the initial stage of the disease a deep incision should be made obliquely from behind the short process of the malleus, backward and downward along a line corresponding with the posterior fold of the drum-head, until the knife meets the canal wall.¹ Or, instead, we may make “a free incision, carried through the distended tissues of the canal well down to the bone, and continued on along to the margin of the auditory plate and well into the membrana flaccida,”² in front of or behind the malleus. This operation is best performed with the knife (Fig. 3) designed by Dr. Samuel Sexton for this purpose.

Subsequent treatment consists in keeping the parts cleansed and aseptic; with internal medication suited to the general condition. The case now is properly one of middle-ear disease, and should be treated as such.³

¹ C. J. Blake, Archives of Otology, 1891.

² S. Sexton, The Ear and its Diseases, New York, 1888, p. 277.

³ See Otitis Media Purulenta, Acuta or Chronica.

In the later stages of this disease, when permitted to pursue a typical course, where the inflammation has already dissected beyond the outlet of the canal, the opening made without for the liberation of the products of inflammation should be supplemented by an incision within the canal opening freely the fistulous tract,—a counter-opening, so to speak. In tympano-mastoid cases where a Wilde's incision is made without and the abscess is opened within the canal also, it is sometimes advisable to pass strands of carbolized catgut through the channel, from one opening to the other.

Granulation tissue forming at the mouth of such wounds should be treated as advised elsewhere, and upon general surgical principles, care being taken especially that the peculiar nipple-like mouth of the wound of the membrana flaccida, when healing, be not mistaken for a polypus; it being, on the contrary, an auspice of further improvement.

Particular attention should be given to this disease of the canal by any one who purposes treating middle-ear disease; for, through imperfect acquaintance with the pathology, indications, and treatment of dissecting otitis externa, much misconception regarding the essentials of drainage from the petro-mastoid antrum is prevalent, and leads to unnecessary suffering and loss of life.

OTITIS EXTERNA DIFFUSA DIPHThERITICA *seu* CROUPOSA.

Inasmuch as the existence of diphtheria or croup of the external auditory canal is not recognized by all authorities, it seems due to the reader, in support of the caption of this chapter, to give some explanation or, preferably, a brief *résumé* of the more important testimonial evidence upon which the identity of the disease seems to have been satisfactorily established.

The following cases, briefly abstracted,¹ may serve the purpose:

Dr. S. Moos² publishes a full history of a case of idiopathic diphtheria of the external auditory meatus. As this case is so often referred to by writers on the subject before us, and as it is so typical, an abstract of it is here appended.

A boy ten years old had been twice under treatment by Dr. Moos for purulent otitis media of the left side,—first from July 24 till November 20, 1864, when he was discharged cured and with the perforation closed; and secondly after an attack of measles, from January 29 till March 19, 1865, when he was discharged cured of otorrhœa, but with persistent perforation. On August 18 he returned to Dr. Moos, *having suffered intense, constant, and increasing earache for thirty-six hours preceding, with fever, loss of appetite, excessive thirst, and during the second night delirium.* Deglutition was easy,

¹ Quoted from the writer's article on Diphtheria of the Ear, in Weekly Medical Review, St. Louis, November 12, 1887.

² Archives of Ophthalmology and Otology, New York, 1861, vol. i. No. 2, pp. 634 *et seq.* Translated by Clarence J. Blake, M.D., Boston, Massachusetts.

but mastication impossible because of its painfulness; patient pale and exhausted; pulse weak and 108 to the minute; furred tongue, and *the palate, tonsils, etc., were clean*; traction on auricle and pressure on tragus painful; glands near by swollen and tender; inner surface of concha bright red; posterior surface of tragus, regio intertragica, and whole surface about outer end of meatus—whose inner portion could not be examined because of contraction—were covered with what is described as “a rather thick, inflexible, lardaceous, greasy coating,” which could not be raised from the underlying structure; attempted separation resulted in only lacerating the parts matted together, with bleeding, and gave the patient intense pain; there was almost total deafness on the affected side, except by bone-conduction; and *though the ear emitted a very offensive odor, there was no positive otorrhœa.*

Treatment consisted in daily pencilling with solution of nitrate of silver (gr. xv to fʒj) and frequently washing the parts with warm water and cold applications of Goulard's solution (one to three), to relieve pain, with good effect. Mastication being painful, fluid food and broths only were given. Local phlebitis was contra-indicated by the poorly-nourished condition of the patient. There was still fever, loss of appetite, and great restlessness at night.

August 26 and 27, insomnia at night. On August 27, coating about the tragus and entrance to the meatus began to peel off, accompanied by slight suppuration and considerable hemorrhage.

August 29, exfoliation began in meatus, accompanied by increased hemorrhage. Syringing produced considerable hemorrhage, and for the first time there was a decrease of the pain.

September 2 and 3, repeated hemorrhage; no pain. On September 3, no fever, increased appetite; hearing-distance for watch, $\frac{5}{2}$; for voice, eight paces; slight tenderness of ear on traction or pressure. Spots on outside of tragus, etc., described above, now show a sharply-marked edge, with slightly granulating and suppurating surface; external meatus presented same appearance; swelling decreased; and, after syringing, speculum was easily introduced, through which old perforation of drum-head was plainly recognized; the drum-head itself was seen to be covered with grayish-red pus, but itself not clearly made out. Improvement followed in external meatus, but a relapse of the otitis media prolonged treatment until October 22, when patient was discharged cured of his disease, but with a persistent perforation as before.

Dr. Moos¹ states that “Wreden has observed five cases of diphtheria of the external ear, and in those most carefully noted the membrana tympani was implicated.”

Dr. Adam Politzer² writes of croupous otitis externa as a rare form of disease of the external meatus, and refers to cases reported by Dr. William

¹ Monatsschrift für Ohrenheilkunde, vol. ii. No. 10, p. 153.

² Treatise on Diseases of the Ear. Cassell's Translation, Philadelphia, 1883, p. 604.

R. Wilde;¹ also to a case, reported by Dr. Gottstein, of croupous exudation of the tonsils and posterior wall of the osseous auditory meatus.

Dr. Bezold² reports eleven cases of this affection met with in three years.

Dr. Politzer says that otitis externa diphtheritica is seldom primary, but is usually a complication of scarlatinal diphtheria of the throat and middle ear. But primary diphtheria of the meatus has been observed and reported by Drs. Moos, Bezold,³ Wreden, Callan,⁴ and Kraussold, which developed during an epidemic of diphtheria, but upon a previously-existing otitis externa, or excoriated condition of the meatus. Dr. Blau mentions the necrosis and shedding of the membrane, and reports a case of diphtheria of the external and middle ears simultaneously. Dr. Jacobson⁵ reports three cases of diphtheria of the canal observed at Dr. Lucae's clinic. Dr. Bezold⁶ reports three cases. Dr. Abraham Jacobi⁷ reports two cases of diphtheria of the external ear, one of which had been the seat of what he calls "catarrhal" inflammation. He cites a case of primary diphtheria of the external auditory canal, reported by Wreden, and refers also to several other cases. Dr. Charles H. Burnett⁸ reports a case where, in a "child sixteen months old, without any previous symptoms of pain or acute inflammation in the ear, a large cold abscess formed behind the auricle, pus ran from the meatus, the abscess was opened by the family's medical adviser, and denuded bone was found extending along the posterior wall of the mastoid portion." This was part of the diphtheritic disease from which the child was at the time suffering. In a report⁹ of over two thousand consecutive cases of ear-diseases will be found mentioned croupous inflammation of the external auditory canal.

Varieties and Occurrence.—This inflammation is of primary or secondary origin; very rarely of the former; but of the latter, quite frequently in neglected, maltreated, debilitated, or scrofulous cases. It seems to develop in some cases of the simple variety of otitis externa diffusa after the exfoliation of the normal superficial tissues. In others it occurs in the after-stages of an attack of true diphtheria of the system. It may appear without obvious otitis media; and it may involve the mastoid, apparently from without. There is a form of the disease, however, to be discussed

¹ Practical Observations on Aural Surgery, London, 1853, pp. 231, 232; *ibid.*, American edition, Philadelphia, 1853, p. 194.

² Virchow's Archiv, vol. lxx. p. 329.

³ Archiv für Ohrenheilkunde, 1878, vol. xiv. p. 66.

⁴ Medical Record, New York, March 27, 1875.

⁵ Archiv für Ohrenheilkunde, 1882, vol. xix. p. 37.

⁶ *Ibid*, 1878, vol. xiv. p. 66.

⁷ Treatise on Diphtheria, 1880, pp. 74, 75.

⁸ Treatise on the Ear, Philadelphia, 1884, p. 461.

⁹ The Classification and Treatment of over Two Thousand Consecutive Cases of Ear-Diseases at Dr. Sexton's Aural Clinic, New York Eye and Ear Infirmary, by Samuel Sexton, M.D., Aural Surgeon, and W. A. Bartlett, M.D., and Robert Barclay, M.D., Assistant Surgeons. Detroit, Michigan, 1886, pp. 82, 86, 89, 94, and 95.

later, closely resembling this; but, unlike it, not characterized by the production of a false membrane in the canal.

Diagnosis.—Physical Signs.—The distinctness of the physical signs may vary considerably in the different cases. Slight redness which soon disappears may sometimes be the only visible phenomenon. There may be a more or less limited or extended, deep or superficial necrosis of the tissues,—a coagulation necrosis,—where, after previous disappearance of their nuclei, the cells become transformed into granular or fibrinous masses which form on the affected surface, loosely or closely adherent, as a gray or whitish membrane. We may find also an exudation of epithelial cells, red blood-cells, leucocytes, and granular matter. The pseudo-membrane may be lying loosely upon the tissue, or may be so closely adherent to it that its removal is attended with severe pain and some hemorrhage; a raw, excoriated surface being left behind; or the pseudo-membrane may form beneath the surface; or an infiltration of the tissue may take place from elements ordinarily composing the pseudo-membrane. With the diseased and adventitious tissue or membranous structure is to be found a variety of dead and living micro-organisms. Prominent among these, essential, and always present, is the *streptococcus* of *Prudden*, sometimes called the *streptococcus diphtheriæ*, permissibly termed the *streptococcus pseudo-membranæ* or *crouposus*, but popularly known by the first of these names. The *bacillus diphtheriæ* of *Loeffler* also may be found in true diphtheria. Of these further mention will be made below.

Attendant on this process may be congestion and swelling of the efferent lymphatic glands. There may be a disintegration or shedding of the pseudo-membrane, with perhaps subsequent ulceration, œdema, phlegmon, or abscess.

In the other form of diphtheria of the external auditory canal the poison of the disease, in its late stages, seems to take hold of the deep tissues of the canal, the tympanum, the mastoid bone, and adjacent lymphatic glands, simultaneously. This is apt to occur in children, especially those who have been poorly nourished, and have been much debilitated by the constitutional ravages of the disease. In these cases the development of the complication in the external ear is apt to be insidious and painless, and, almost before we are aware that a serious complication has arisen, there may be extensive destruction, with necrosis, and burrowing to neighboring parts; and upon this may follow rapidly fetid discharges,—often persistent, always annoying and disgusting,—deafness, erosion of the Eustachian tube, mastoid perforation and necrosis, facial paralysis (Bell's palsy), meningitis, thrombosis, embolism, phlebitis, pyæmia or encephalitis, and death.

Prognosis.—As said before, the primary form, although attended by greater pain and the production of the superficial pseudo-membrane, is, if properly treated, less apt to be widely destructive. But the secondary form, on the other hand, though less painful, and with the diphtheritic poison working within, not upon, the tissues of the canal, is swift, insidious, and extensive in its ravages, and may pass rapidly into the chronic or fatal

state. It is in this form especially that neglect or error of treatment is apt to lead to the formation of sinuses, redundant granulation-tissue, polypi, dissecting cervical abscess, lymphangitis, etc.

Etiology.—Regarding the etiology of diphtheritic and croupous inflammation of the auditory canal, this may be said :

“The bacillus of *Loeffler* is the causative agent in what we may call true diphtheria. Aside from true diphtheria there is a series of lesions, pseudo-membranous and sometimes fatal, which have generally been called diphtheria or croup. The latter disorders are apparently caused by a *streptococcus*,” sometimes called the “*streptococcus diphtheriæ*,” which is “not the cause of true diphtheria, although occurring frequently enough in it,” “apparently the germ which does cause suppurations and a variety of lesions ; in a word, probably identical with *streptococcus pyogenes*, *streptococcus erysipellatis*,” but popularly known by the name of “the *streptococcus* of *Prudden*.”¹

Treatment.—Inasmuch as this disease is apt to occur as a complication or feature of diphtheria, or in the greatly debilitated, treatment will be such as advised elsewhere for diphtheria. It should be borne in mind that the disease is insidious and may without warning become widely destructive and perhaps fatal. The ear should therefore be closely watched throughout diphtheria. Whether the disease be primary or secondary, local or constitutional, treatment should be modified to suit the individual case. When the ear becomes invaded, if seen early, aconite may be given. Mercury, to reduce the plasticity of the blood and limit fibrinous exudation, is useful : corrosive bichloride of mercury, gr. $\frac{1}{32}$ to $\frac{1}{8}$, or calomel, gr. $\frac{1}{6}$ to $\frac{1}{4}$, every hour, until “frog-spawn,” frothy stools show that the mercury is acting. If the aural trouble persist or increase, operate at once upon any place where there seems reason to believe that secretions are forming : liberate them. To remove the false membrane, try lime-water ; lactic acid in solution, gr. xxx to each fluidounce ; one of the digestive ferments, trypsin, pepsin, or extract of pancreas ;² peroxide of hydrogen (an excellent agent) ; or instrumental means. Then irrigate thoroughly with a solution of corrosive sublimate (bichloride of mercury) one to two thousand ; dry the parts with absorbent cotton ; and then dress the excoriated surface with iodoform, boro-iodoform, aristol, or boro-aristol, and protect antiseptically with cotton wool.³ Special attention should of course be given to the treatment of the general disease.

¹ For an exhaustive exposition of this subject the reader will do well to consult the historical summary and report of experimental studies on the etiology of diphtheria by T. Mitchell Prudden, M.D., in the *American Journal of the Medical Sciences*, Philadelphia, May, 1889, and the *Medical Record*, New York, April 18, 1891. He may read also J. C. Cameron, “Diphtheria and True Croup,” *Hare's System of Practical Therapeutics*, Philadelphia, 1892, vol. ii. pp. 485–518, for an able exposition of the subject of diphtheria and croup in general.

² Robert T. Morris, *Medical Record*, New York, April 11, 1891.

³ See J. C. Cameron, “Diphtheria and True Croup,” *Hare's System of Practical Therapeutics*, Philadelphia, 1892, vol. ii. p. 515.

OTITIS EXTERNA DIFFUSA GANGRÆNOSA.

This is, as a rule, a consequent of the diphtheritic form of inflammation, occurring usually in broken-down constitutions in childhood or old age. It is due to a stagnation of blood, or strangulation by inflammatory products, in large portions of the membrane or tissue of the canal. Those parts then die and become the home of micro-organisms, subsequently sloughing off *en masse*. It is nearly akin to the necrotic process which attends one form of the diphtheritic diffuse otitis externa, but is more superficial at the outset, and less inclined to spread deeply. In its destructive nature and behavior it somewhat resembles the serpiginous syphilide, for which it may be mistaken. It stands, as it were, midway between diphtheritic otitis externa and necrosis of the tissues, the latter of which it virtually is.

The indications for treatment are for remedies, internally, mainly supporting; locally, cleansing, antiseptic, and emollient; similar in general to those of diphtheritic diffuse otitis externa,—with this exception, however: that particular pains should be taken to support and improve the general health.

OTITIS EXTERNA DIFFUSA SYPHILITICA.

That syphilis may produce a characteristic inflammation of the external auditory canal is denied by some, is held *sub judice* by others, and is unequivocally affirmed by many.

Characteristic Features.—This is usually a disease of the tertiary stage of syphilis. Some local exciting cause may usually be found for all such syphilides.¹ This may be any one of those already cited as causative of simple otitis externa. As a rule, the disease is unilateral. The later in the specific condition it occurs, the more profound, sluggish, obstinate, and chronic it tends to become. The crusts of syphilitic pustules and ulcers are usually upon an indurated base, not sharply defined; if elevated, the crust may cover a deep ulcer whose base and margins are brownish-red and infiltrated; if the eruption be simple, the ulcer is superficial, upon an inflamed base, and has a violaceous reddish rim.

Diagnosis.—The later the syphilitic ulcer or inflammation, the darker, rougher, dirtier the crusts will appear,—brownish-black, by which they may be distinguished from crusts of lupus, which are somewhat bluish-brown, mottled or streaked with yellow, and are usually found in early life. "Although superficial carcinomatous tubercles may somewhat resemble those of syphilis, they are never so scattered, and are always much larger, sometimes involving an entire region."² The differential diagnosis of syphilis and cancer of the external auditory canal is detailed in the chapter on Malignant Diffuse External Otitis, and need not be introduced here.

¹ Bumstead and Taylor on Venereal Diseases, 1879, p. 511.

² *Ibid.*, p. 549.

Condylomata, frequently found in the external auditory canal, "are large, flat, overgrown papules, with excoriated, oozing surfaces and a tendency to great multiplication and to exuberant development."¹

One of the late syphilides—the tubercle, the pustule, or the ulcerating gumma—may be the starting-point of a deep serpiginous syphilide. This is a rapidly-spreading, deep, sharply-cut ulcer, with undermined edge and incrustated as described above. It may or may not be attended with pain; and it tends to become chronic. Often it is quite disfiguring.² It may eventuate in sluggish granulations or unsightly and disabling cicatrices, as referred to above. "In opposition to the view of some that this eruption is not syphilitic, it is only necessary to add that it always begins in a syphilitic lesion, that its ulcers and crusts have features similar to those of other syphilitic lesions, and, finally, that its cicatrices are typical of syphilis."³

In appearance the lesion is not specially characteristic of syphilitic inflammation of the canal; but its behavior, as described above, with other evidences of former active syphilis, and with a syphilitic history indisputable in some cases, would place the stamp of probability on the diagnosis of syphilitic otitis externa. Pain may or may not be a symptom. There may be a sense of fulness, tension, or dragging in the ear, with tinnitus and autophonia. In some cases deafness may be a concomitant; and it may be profound. As a rule, the sudden deafness of syphilis does not fall upon syphilities during diffuse external otitis.

Prognosis.—The prognosis depends largely upon the constitution, nutrition, habits, age, and surroundings of the patient; upon his abstemious and temperate conduct; upon his intelligent co-operation in medicinal and hygienic treatment; and upon the uncomplicated nature of the local inflammation. The course of the disease is apt to be sluggish, at best.

Treatment.—The treatment of syphilis of the external ear should be local and constitutional, medicinal and hygienic. First, give your patient a clear understanding of his condition and of the necessity of attending to it. Look after his hygiene, regimen, and surroundings. Prohibit, as far as possible, the use of tobacco and alcoholic beverages.

If the ear-disease occur during the secondary stage of syphilis, give protiodide of mercury, gr. $\frac{1}{4}$ or $\frac{1}{3}$ to $\frac{1}{2}$ at a dose, in pill form, three times a day. If necessary, increase the dose, not beyond three grains a day, and gauge the increase by the local and general effect. Let the patient have sweat-baths, Turkish baths without the cold plunge, or hot baths on retiring at night. Later in syphilis employ the "mixed treatment." "Late secondary and tertiary lesions of the skin and mucous membrane, affections of the bones, periosteum, and joints, late-appearing affections of the eye,

¹ Robert W. Taylor, Hare's System of Practical Therapeutics, Philadelphia, 1892, vol. ii. p. 155.

² Barclay, Journal of Cutaneous and Genito-Urinary Diseases, New York, March, 1888.

³ Bumstead and Taylor, loc. cit., p. 557.

ear, and cerebro-spinal system, of the viscera, and of the testes and penis, require a combination or mixed treatment. In many cases it is necessary to increase the dose of the iodide far beyond those already mentioned."

"It must be remembered that the arbitrary rule laid down by some authors, that early in syphilis mercury is indicated, and that later on the iodide alone should be given, is not, in general, a good one. Many a case of tertiary syphilis has remained unaffected by the use of the iodide alone, and has promptly improved and soon recovered after mercury also was given. The use of mercury, therefore, should not be limited to the secondary stage, but should also be employed in tertiary syphilis, either by inunction or hypodermic injection, combined with the iodide given internally."¹

Try

R Hydrarg. biniodidi, gr. i-ij;
Potassii iodidi, \mathfrak{z}_{ss} - \mathfrak{z}_j ;
Syr. aurantii cort., $\mathfrak{f}\mathfrak{z}_{ij}$;
Aquæ, $\mathfrak{f}\mathfrak{z}_j$.—M.

Sig.—One teaspoonful three times a day, an hour after eating, in a wineglassful of water. (Taylor.)

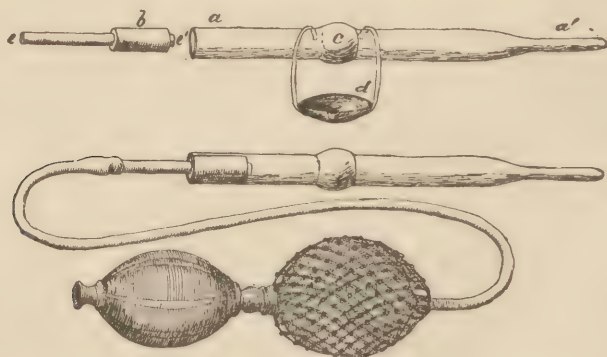
Or

R Hydrarg. bichloridi, gr. j-ij-ijj;
Potassii iodidi, \mathfrak{z}_{ss} - \mathfrak{z}_j - \mathfrak{z}_{iss} ;
Tinct. cinchonæ comp., $\mathfrak{f}\mathfrak{z}_{ijss}$;
Aquæ, $\mathfrak{f}\mathfrak{z}_{ss}$.—M.

Sig.—To be taken in the same manner as the foregoing. (Taylor.)

Inunctions of mercurial ointment at the affected region, and in some cases hypodermatic administration of a mercurial, are of great service. A

FIG. 4.



Kane's apparatus for local mercurial fumigation. (After Taylor.)

very neat way of making local mercurial fumigation or application is with the apparatus devised by Dr. F. B. Kane.² (Fig. 4.)

¹ Robert W. Taylor, *loc. cit.*, p. 61.

² "Mercurial Fumigation: Description of a New Apparatus." *Dublin Journal of the Medical Sciences*, November, 1874.

"This consists of a glass tube about ten inches long, drawn out to a fine nozzle at *a'*, and cut off with a file at *a*, the edge being rounded off so as not to cut the cork *b*, and a slight bulbous expansion at *c*; the cork is made to fit *a* and hold tightly the small glass tube *e e'* which passes through it, and a metal cup, *d*, is suspended by two wires about two inches under *c*. From five to ten grains of calomel are introduced into the glass tube as far as the bulb on the point of a pen, the cork is inserted into the large end of the tube, the end of the glass tube is attached to the rubber part of a spray apparatus, and a small piece of rolled-up lint, or a small wire cylinder filled with asbestos and saturated with alcohol, is placed in the cup and then lighted. While the calomel in the bulb is being sublimed, a gentle current of air is forced through the tube. The result is the deposit of a film of sublimed calomel on the surface of the sore. The nozzle of the tube should be held at a distance of from one to three inches from the skin. The fumigation is easy of application, and harmless even on very sensitive parts. It causes no unpleasant results, and is usually not followed by salivation." (Taylor.¹)

With this or similar apparatus a film of calomel (or iodoform if preferred) can be deposited upon the walls of the canal or upon the sorest part thereof.

The papular form of this disease should be treated with hot baths, alkaline or sulphur, and by inunction of mercurial ointment. Should a soothing ointment be required, try

R Unguent. diachyli (fresh), ℥ij;
 Unguent. hydrarg. nitratis, ℥j;
 Olei rusci, ℥ss.—M. (Taylor.)

Or a solution of hydrarg. bichlorid. corrosiv., gr. i-iv to ℥j of either colloidium flexile or traumaticin.

For condylomata, carefully wash the parts with the following:

R Liquor. sodii chlorinat. (Labarraque's), part. j;
 Aquæ destillat., part. vi.-viii.—M.

Afterwards dry the parts; dust with calomel; and protect with cotton. Or cleanse the parts, and then touch the lesions with a solution of nitrate of silver, gr. xxx to f℥j. In some cases, tinct. ferri chloridi may be applied with advantage, and without discomfort. In others, tincture of iodine or a tincture of iodine of double strength would be of service, especially in marked cases.

In the serpiginous ulcer with redundancy of tissue, if the adventitious tissue be slight in amount, touch the part with nitric or carbolic acid. If this be too weak to destroy and remove the useless parts, then employ the curette therefor.

¹ Hare's Therapeutics, vol. ii. pp. 94, 95.

In every case, the patient's strength should be supported by wholesome diet, systematic and regular physical exercise, diversion and amusement, and medicinal tonics, as indicated.

OTITIS EXTERNA PARASITICA.

The external auditory canal may become the home of certain parasitic organisms, vegetable as well as animal, and, in consequence, inflamed. The presence of animal parasites in this recess, with its attendant phenomena, is a subject whose discussion is customarily relegated to the chapter on foreign bodies in the ear; wherefore, in deference to custom, information thereupon may, in this work, be sought under that caption.

The phenomena attending the growth of vegetable parasites, however, are so peculiarly characteristic, and the history of the disease, as reported, is so fraught with interest, as to have received the closest study by otologists ever since Wreden in Europe and Charles H. Burnett in this country brought it so ably to their notice. And this study proves serviceable particularly for practical ends, inasmuch as the morbid condition under consideration—which by some seems to be encountered quite frequently—may, if not properly managed, become intractable and, to the patient, distressing.

The disease is well known under various names. *Otomycosis*, from the fact that the aural vegetable parasite is usually one of the fungi, was, as a generic name for the disease, first suggested by Virchow.¹ *Myringomycosis Aspergillina*, as a more specific name, was first suggested by Wreden, of St. Petersburg,² from a knowledge of the fact that the fungus is usually one of the species *Aspergillus*, and that it makes its home, as a rule, first upon the drum-head. *Myc-myringitis*, *Myringitis Parasitica*, *Aural Fungi*, *Fungous Otitis*, *Aspergillus of the Ear*, *Otitis Parasitica*, *Ear-Mould*, and numerous other names have been suggested, of which a choice is usually made according to taste.

Varieties.—The disease presents clinical as well as mycological varieties. Clinically, it may be of a type so pronounced as to be attended by intense suffering; it may, on the contrary, be so mild as to escape the notice of the patient; or, finally, it may appear in any grade of severity between these two. The more severe cases are, as a rule, those attending the growth of *Aspergillus niger*; the more mild, *Aspergillus glaucus*. Curiously enough, the relative size of the fruit of these plants corresponds usually with the relative intensity of the disease produced by them, a fact which gives additional weight to the suggestion of Dr. Charles H. Burnett,³ of Philadelphia, that for practical diagnostic purposes we might give to the fungi *Aspergillus niger* and *Aspergillus glaucus*, respectively, the names *Aspergillus major* and *Aspergillus minor*.

¹ Virchow's Archiv, vol. ix.

² St. Petersburg Medicinische Zeitschrift, 1867, vol. xiii.

³ American Journal of Otology, vol. i. No. 1, January, 1879.

Mycologically, the disease varies considerably in the different cases. And while there are but few species of moulds generally found within the ear, nevertheless there have been reported a numerous variety of those exceptionally met with.¹

Occurrence.—The disease is to be met with at any season of the year,—perhaps more frequently in the autumn,—and in almost any locality. There are some reasons for thinking that it is less prevalent after a long-continued drought. It is thought by some that it most frequently affects those who dwell in damp or dark apartments. Not uncommonly it affects several persons who occupy the same apartments. There seems reason to believe that it occurs most frequently among rural inhabitants. In the aged and the young it is rarely found, according to accepted reports. It seems to have occurred at times with uncommon frequency in the practice of certain physicians; but whether this was from partial cleansing of instruments, from imperfect cure or neglect to remove waste products of former ear-disease, from the employment of oleaginous or unguentous aural applications, from more careful observation, perhaps, or from other cause, must be conjectural only. In regard to its frequency in otological practice, estimates of different authorities differ widely; perhaps because of unequal care in observation on their part; possibly because of differences in the class of patients observed by them severally. For instance, Bürkner² gives the following as the percentage of cases of otomycosis in the otological practice of different observers: Bezold, 1 per cent.; Hedinger, 0.5 per cent.; Bürkner, 0.1 per cent.; Burckhardt-Merian, 0.3 per cent.; Knapp, 0.1 per cent.; Marian, 0.3 per cent.; Gruber, 0.1 per cent.; Roosa, 0.4 per cent.; Shaw-Blake, 0.1 per cent.; Lucae, 0.09 per cent.; Schalle, Tröltzsch, and De Rossi, 0.0 per cent. The percentage in private practice, exclusively among “the better classes,” so called, is considerably higher than this, which may not be surprising when we reflect that the species of *Aspergillus* are known to thrive on masses of fatty matter in a state of decomposition, and that before seeking the advice and aid of a physician for the relief of symptoms of presumed ear-disease, it is customary for “the better classes” to “try” the “ear-drops” prescribed by an apothecary or friendly layman. The disease occurs chiefly in those who have previously suffered from an otitis, sometimes suppurative, sometimes desquamative or ulcerative, but very frequently of that form which we term circumscribed otitis externa, aural furuncle, or boil in the ear. It is rarely, if indeed ever, found with purulent otitis. It may develop after a fissure or an abrasion of the skin of the canal, or after aural instillation of fatty or oily substances. Now, intense aural pruritus inciting an irresistible desire to “scratch” violently the walls of the auditory canal,

¹ A history of the discoveries already made of different species and varieties of moulds, with bibliography, and description of the moulds and of their manner of growth and reproduction, will be found in connection with the discussion of diagnosis by microscopic examination.

² Archiv für Ohrenheilkunde, vol. xx. p. 2.

quite frequent in diabetes mellitus, may lead to the production of such a solution of continuity. And aural furuncles—often preceded by such intense pruritus, hard scratching, and wounding of the canal wall—are a common phenomenon in diabetes mellitus. Moreover, we learn that “some fungi” (*e. g.*, *mucor*),¹ “. . . allowed to grow freely at the surface of a saccharine liquid, assume the ordinary aerial form peculiar to that species of fungus;” on the other hand, “if submerged in the same liquid, ‘breaking up’ by a process of constriction into short lengths, which separate, acquire rounded forms, and at the same time multiply by budding after the manner of *torulæ*,” these changes being attended by “an active fermentation in the fluid, so that this ‘*mucor torula*’ functionally, as well as morphologically, deserves the name of ‘yeast.’” “If the *mucor torula* is filtered off from the saccharine solution, washed, and left to itself in moist air, the *torulæ* give off very short aerial hyphæ, which terminate in minute sporangia. In these a very small number of ordinary *mucor* spores is developed; but in essential structure both the sporangia and the spores resemble those of normal *mucor*.”²

The influence of a small amount of saccharine solution upon tissues otherwise invulnerable to certain micro-organisms, by virtue of which these tissues may become inflamed and purulent through an invasion by these micro-organisms, has been demonstrated by Bujwid.³

These facts, taken together, seem to suggest a possible etiological connection, mediate or immediate, between the insidious metamorphosis preceding changes in the urine characteristic of diabetes mellitus, and the liability to otomycosis; may it not, therefore, be said that diabetes mellitus is one of the conditions predisposing to otomycosis? But otomycosis may occur in an ear which has previously exhibited no appreciable pathological phenomena. Now, inasmuch as the germinal cells, spores of fungi, float about everywhere in the atmosphere, with harm to but few, the presumption is that there must be in the healthy ear a vital power of resistance sufficient to afford that organ immunity from the encroachment of fungous parasites.

Whether the nature of aural fungi, while growing within the ear, be obligative or facultative, invariably or circumstantially saprophytic or parasitic, has not as yet been determined to the satisfaction of all. For instance, aural fungi by De Bary are supposed to be saprophytic,⁴ but he holds that the products of decomposition attending the development of these paraphytes are water, carbon dioxide, ammonia, and organic compounds transformed to a more elementary condition; these, in contact with living tissues, are capable of inducing inflammation.⁵ Steudener considers them sapro-

¹ Huxley, A Course of Practical Instruction in Elementary Biology, London, 1875, p. 5.

² Huxley, *loc. cit.*, p. 36.

³ Centralblatt für Bakteriologie und Parasitenkunde, Bd. iv. No. 19.

⁴ Hoffmeister's Handbuch d. Physiologischen Botanik, 1866, Bd. ii. Abth. i. S. 225.

⁵ *Loc. cit.*, S. 231.

phytic.¹ Virchow holds² that they are saprophytic and therefore circumstantial or *a posteriori* evidence of organic disease and degeneration. Weber-Liel (F. E. Weber)³ believes that aural fungi are parasitic until the death of the tissue by which they are nourished, when they become saprophytic and devour it. It may be said that it is only over the dead body of its victim that the ascomycete raises its victorious ascospore.⁴ There have been reported by A. Politzer⁵ and J. Gruber⁶ cases where the mycelial growth has penetrated and destroyed the tissues of the drum-head in the living animal.

But, though eminent authorities differ in opinion respecting the obligative or facultative nature of the various moulds while growing within the ear, and though decomposing matter, a furuncle, a fissure, an abrasion, a superimposed, adventitious pabulum suited to the plant, or any other one particular circumstance or condition of the ear has not as yet been proved the *sine quâ non* of the growth of aural moulds, it nevertheless seems reasonable to infer *a posteriori*, from the exceptional occurrence of otomycosis in general while the conditions just mentioned are so prevalent, that there must necessarily be first established in the ear some abnormal condition or circumstance, functional or organic, favorable to the growth of moulds; some diminution of the vital power of resistance in the tissues, whether from atony, disorder, degeneration, or disease; local vaso-motor paresis through exhaustion of the regulating sympathetic ganglion by prolonged irritation from another part of the sympathetic area under control of this ganglion; disorder of dermatic secretion or excretion through inhibition or over-stimulation of the trophic nervous apparatus of the part; abnormal humidity of the tissues, patency of the fissures of the epidermis, serous exudation, or any other condition whatsoever, if only characteristic of a so-called *locus minoris resistentiæ*; whereupon, and whereupon only, could it be possible for the fungus to maintain, if indeed it could once even "stake its claim"⁷ for support within the ear.

Turning our attention now from the predisposing to the exciting cause of the disease, we find, as before stated, that it consists essentially of the growth, or vegetation and fructification or reproduction, of a mould within the ear. Some otologists maintain that to discover a *mycelium* only in the ear,

¹ Hoffmeister's Handbuch d. Physiologischen Botanik, 1866, Bd. ii. S. 107.

² Virchow's Archiv, Bd. x. Hft. 4, S. 557 u. f.

³ Monatsschrift für Ohrenheilkunde, 1868, Bd. ii. Hft. i. Ss. 10-13.

⁴ See Meade Bolton in Buck's Reference Handbook of the Medical Sciences, New York, 1888, vol. vii. p. 327.

⁵ Wiener Medicinische Wochenschrift, 1870, 287.

⁶ Lehrbuch der Ohrenheilkunde, 1870, S. 316-319.

⁷ To wit, form "submerged hyphæ;" thus: "On the other hand, the attached surface" (*sc.* of the mycelial crust of the mould) "gives rise to a like multitude of longer-branched hyphæ, which project into the fluid in which the crust is growing, like so many roots, and may be called submerged hyphæ." T. H. Huxley and H. N. Martin, "A Course of Practical Biology," London, 1875, p. 30.

and to cultivate it to fructification, for identification of the *mould*, by any method outside the ear, does not suffice for a diagnosis of otomycosis; nor does the discovery of a *mould* growing upon a foreign body within the ear—as, for instance, *Eurotium repens* upon aural cerumen. But it is held by others that inasmuch as inflammation is often established by the vegetation of *hyphæ*, by the growth of mycelium alone, this position is untenable. By microscopic examination alone, as described below, are the growth and identity of the *mould* to be positively recognized, a magnifying power of at least $300\times$ being necessary for satisfactory work.

The correct mycological classification of an aural mould depends upon a recognition of its physiological and morphological features, sometimes most remarkably varied through the different stages of growth. To insure absolute identification of such a mould, and to examine scientifically its phenomena and mode of growth and reproduction, artificial culture, so called, as hereinafter described, may in some cases be necessary. The physician should know, as far as possible, what moulds have been already discovered growing within the ear, and the distinguishing characteristics of each.

What moulds in particular are these? and what are the modes of growth and reproduction and the distinguishing characteristics of each?

They are numerous; but the principal are the following:¹

I. *Aspergillus nigrescens* Robin, by Mayer.² (Fig. 5.)

II. *Aspergillus niger* Van Tieghem, by Pacini.³ (Figs. 6 and 7.)

III. *Aspergillus flavus* Brefeld, by Grove;⁴ also by Voltolini;⁵ *A. fl.* Van Tieghem, by R. Wreden.⁶ (Fig. 8.)

IV. *Aspergillus glaucus*, by Schwartz,⁷ by F. E. Weber (Weber-Liel),⁸ and, from his own personal experience, by J. Orne Green.⁹

V. *Sterigmatocystis antacustica* Van Tieghem, by Carl Cramer.¹⁰

VI. *Aspergillus flavescens*, by R. Wreden;¹¹ also by Josef Gruber.¹²

¹ As far as possible there have been appended to each of the following the names of the early discoverers and the original reports of their discovery.

² Müller's Archives of Anatomy, 1844, p. 404, Tab. X. Figs. 1-4.

³ Sopra una muffa parasita (Mucedo) nel condotto auditivo esterno. Gazz. med. ital. feder. tosc., Firenze, 1850, 2, S. i.; also reprinted by M. Cecchi, Florence, 1851.

⁴ A Fungous Parasite, etc. Read before the Microscopical Society, London, April 15, 1857.

⁵ Monatsschrift für Ohrenheilkunde, 1870, p. 9.

⁶ See *Aspergillus nigricans*.

⁷ Monatsschrift für Ohrenheilkunde, 1865, Bd. ii., Hft. i., S. 5.

⁸ Ibid., 1868, Bd. ii., Hft. i., Ss. 10-13.

⁹ Transactions of the American Otological Society, 1869, pp. 25, 26.

¹⁰ Vierteljahrsschr. d. Naturforsch. Gesellschaft zu Zürich, 1859 and 1860.

¹¹ Archiv für Ohrenheilkunde, 1867, Bd. iii., Hft. i., Ss. 1-21; Taf. 1; Sitzung von 27. August, 1867, des ersten internationalen Congresses der Aerzte zu Paris; Comptes-Rendus de l'Académie des Sciences, August 29, 1867; "Die Myringomycosis Aspergillina und ihre Bedeutung für das Gehörorgan," St. Petersburg, 1868; St. Petersburger Medicinische Zeitschrift, 1867, vol. xiii.

¹² Lehrbuch der Ohrenheilkunde, 1870, Ss. 316-319.

FIG. 5.



Mayer's fungus from the external ear, showing the "simple, not swollen, internally-granulated filaments," and the "developed fungus, with spores on its capitulum." (After Küchenmeister.)

FIG. 6.



ASPERGILLUS NIGER, $\frac{3}{1}$ °. (After Siebenmann.)

FIG. 7.



PACINI'S EAR-FUNGUS. (After Küchenmeister.)

FIG. 8.



ASPERGILLUS FLAVUS, $\frac{3}{1}$ °. (After Siebenmann and Flügge.)

VII. *Aspergillus nigricans*, by R. Wreden (in same report with *Aspergillus flavescens*, above).

VIII. *Aspergillus fumigatus* Fresenius (Fig. 9), by Mayer (see *Asper-*

FIG. 9.



ASPERGILLUS FUMIGATUS, $\frac{2}{3}$ °. (After Siebenmann.)

FIG. 10.



PENICILLIUM GLAUCUM (branch and fruit). (After Flügel.)

gillus nigrescens, above); *A. fumigatus* Siebenmann, by Pacini (see *Aspergillus niger*, above); also by Josef Gruber.¹

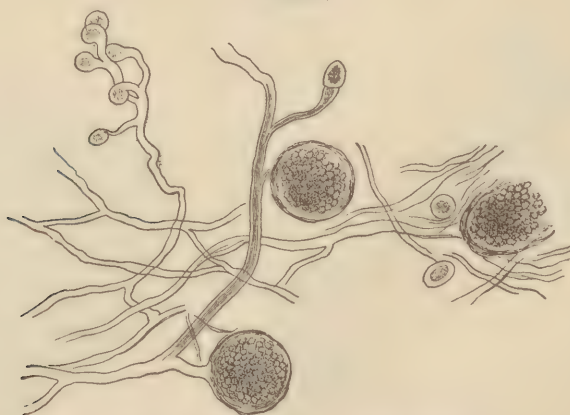
IX. *Otomyces Hageni*, by Hagen and Hallier.²

X. *Aspergillus ramosus*, by Hagen and Hallier.

XI. *Acrostalagmus parasiticus*, by Hagen and Hallier.

XII. *Penicillium* of *Stachylidium*, by Hagen and Hallier.

FIG. 11.



OTOMYCES PURPUREUS, $\frac{2}{3}$ °. (After Wreden.)

XIII. *Stachylidium* (*Acrostalagmus*), by Hagen and Hallier.

¹ Monatsschrift für Ohrenheilkunde, 1870, Bd. iv., S. 113.

² Zeitschrift für Parasitenkunde, 1869, Bd. i., Ss. 199-202, 368-374; 1870, Bd. ii., Ss. 22-29, 232-241.

XIV. *Penicillium* (Fig. 10), by Hagen and Hallier.¹

XV. *Trichothecium roseum* Link, by Hagen and Hallier.

XVI. *Tilletia*, by Hagen and Hallier.

XVII. *Stysanus stemonitis*, by Hagen and Hallier.

XVIII. *Torula rufescens*, by Hagen and Hallier.

XIX. *Stemphylium polymorphum* Bon, by Hallier-Hassenstein.²

XX. *Graphium penicilloides* Corda, by Hallier-Hassenstein.

XXI. *Trichothecium roseum* Link, by Steudener.³

XXII. *Mucor mucedo* seu *fuscus* Fresenius, by J. Böke.⁴

XXIII. *Aspergillus microsporus* Hallier, by J. Böke (in same report with *Mucor mucedo* seu *fuscus*, above).

FIG. 12.



MUCOR CORYMBIFER (sporangia before and after rupture of their membrane). (After Lichtheim.)

XXIV. *Otomyces purpureus* Woronin (Fig. 11), by R. Wreden;⁵ also by Swan M. Burnett.⁶

¹ Zeitschrift für Parasitenkunde, 1869, Bd. i., Ss. 199-202, 368-374; 1870, Bd. ii., Ss. 22-29, 232-241.

² Zeitschrift für Parasitenkunde, von Hallier und Zürn, 1869, Bd. i., Hft. 2, Ss. 111-113, 199-202, 275; 1870, Bd. ii., Ss. 250-280. (See *Trichothecium roseum*, above, and *Verticillium graphii*, below.)

³ Archiv für Ohrenheilkunde, 1870, Bd. v., Ss. 163-168.

⁴ Hungarian Medico-Chirurgical Press, 1868, pp. 9, 12, 16, 19; also, Monatsschrift für Ohrenheilkunde, 1869, Bd. iii., S. 58.

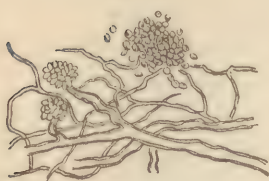
⁵ Archiv für Ohrenheilkunde, 1867, Bd. iii., Hft. 2; translated by Charles H. Burnett, Archives of Ophthalmology and Otology, 1874, vol. iv. No. 1, pp. 87-91.

⁶ Archives of Otology, vol. x. p. 318.

XXV. *Ascophora elegans*, by Von Tröltsch.¹

XXVI. *Ascophora mucedo* Schenck, by Von Tröltsch.

FIG. 13.



A bastard form of *Penicillium glaucum*, as sketched by Blake.

XXVII. *Mucor corymbifer* Lichtheim (Fig. 12), by A. Huckel;² by Prof. Wagenhäuser;³ by F. Siebenmann;⁴ also by H. Graham.⁵

XXVIII. *Eurotium malignum*, by W. Lindt.⁶

XXIX. *Penicillium (glaucum)*, bastard form (Fig. 13), by C. J. Blake.⁷

XXX. *Penicillium minimum* Siebenmann, by F. Siebenmann.⁸

XXXI. *Aspergillus rubens*, by J. Orne Green.⁹

XXXII. *Verticillium graphii* Harz-Bezold (Fig. 14), by F. Siebenmann;¹⁰ also by Hallier.¹¹

FIG. 14.



VERTICILLIUM GRAPHII (HARZ-BEZOLD), 399. (After Siebenmann.)—Showing—*a*, stem-formation; *b*, normal fruit-bearer, young growth; *c*, older spore, fallen off; *d*, older mycelium.

¹ Lehrbuch d. Ohrenheilkunde, 2d ed., "Otitis Externa."

² Beiträge zur pathologischen Anatomie und Physiologie, von Zeigler und Nauwerck, Jena, 1884.

³ Lichtheim's Essay on Two New Kinds of Mucor, Zeitschrift für Klinische Medizin, Bd. vii., Hft. 2.

⁴ Archiv für Ohrenheilkunde, Bd. xix.; translated, Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, p. 249.

⁵ Lancet, London, December 27, 1890.

⁶ Archiv für experimentelle Pathologie und Pharmacie, Bd. xxv., Hft. 3 und 4.

⁷ Transactions of the American Otological Society, 1869, pp. 23-26.

⁸ Archiv für Ohrenheilkunde, Bd. xix.; translated, Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, pp. 250, 251.

⁹ Proceedings of the Boston Society of Medical Sciences, November 19, 1868.

¹⁰ Archiv für Ohrenheilkunde, Bd. xix.; translated, Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, pp. 257-260.

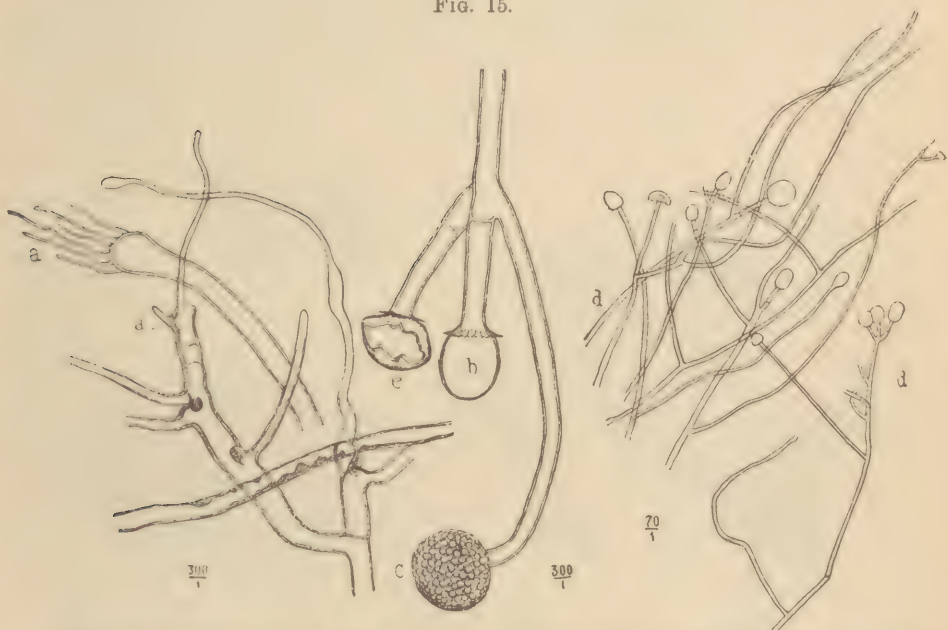
¹¹ Under the names of *Graphium penicilloides* and *Stemphylium polymorphum*, above, *q. v.*

XXXIII. *Mucor septatus* Bezold (Fig. 15), by F. Siebenmann.¹

XXXIV. *Aspergillus nidulans* Eidam-Lindt (Fig. 16), by F. Siebenmann.²

Now, the reader should be warned at once that the foregoing list is liable to be challenged as erroneous and confusing, drawn as it is from the literature of otomycology, which is full of errors and confusion inexplicable to all unacquainted with mycology. In explanation and extenuation, in behalf

FIG. 15.



MUCOR SEPTATUS (BEZOLD), ♀♀. (After Siebenmann.)—Showing, *a*, rhizoid formation; *b*, columella, bare (after rupture of peridium); *c*, sporangium; *d*, fruit-bearers with burst sporangia; *e*, torn and compressed columellæ.

of otological literature, let the reader reflect that the opportunities for acquiring familiarity with the pleomorphic features of moulds and for acquiring skill in the technique of their artificial culture have fallen to the lot of few of the observers mentioned above. And inasmuch as these plants, from their embryonic to their adult state, vary widely in their morphological and physiological characteristics under different conditions and circumstances,—in short, seem to the uninitiated almost protean,—and as each observer has, in the classification of moulds, adopted that particular system and nomenclature which in his opinion seemed most rational, there being great diversity among these, what wonder is it that errors and confusion prevail! But that the reader may with increased interest pursue

¹ Archiv für Ohrenheilkunde, Bd. xix.; translated, Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, pp. 236, 262-264.

² Archiv für Ohrenheilkunde, Bd. xix.; translated, Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, pp. 240, 248, 249.

the history of the discovery of these aural moulds, and pass with more satisfaction to its results, without having the subject wholly befogged by the confusion apparent on the surface, it seems prudent to attempt a general but brief *résumé* of the chief phases of the controversy respecting each of the identifications (or classifications, if you prefer) of the foregoing list.

I. *Aspergillus nigrescens*, so called by Robin, was in his first edition called *Mucor mucedo*. (See Küchenmeister.) It is supposed by F. Siebenmann to be *Aspergillus fumigatus*,¹ and by T. Küchenmeister to be an *Aspergillus*.² In speaking of Pacini's fungus, Küchenmeister says that "the

FIG. 16.



ASPERGILLUS NIDULANS. I. 390. (After Siebenmann.)—Showing, a, older fruit-head with indistinct structure of the sterigmata, conidia mostly fallen off; b, fruit-receptacle with cup-shaped top; c, younger fruit-head, the fallen-off conidia lying close by as a mass consisting mostly of parallel chains, d, e, older conidia, partly in chains. II. and III. (After Eidam. From Winter.)—II. Showing "fertile hypha from the mature sclerotium, with one mature and several young sporangia" [*Schläuchen*]. III. Showing "spore-sac [sclerotium] surrounded by its capsule and the conidianiferous mycelium."

capitulum of the fructifying elements was completely spherical, that of Mayer's ear-fungus pear-shaped."³

II. *Aspergillus niger* Van Tieghem, called *Mucor mucedo* by Pacini, who mistook the hyphæ for algæ spores. Küchenmeister says of it, "From the external appearance it can only be considered an *Aspergillus*, similar to Mayer's ear-fungus, or a *Mucor mucedo*. I believe the last is the most probable, because the sporangia have that fringed, fan-like appearance characteristic of *Mucor mucedo*. The mature spherical spores . . . range themselves in rows joined to one another, and radiate from the placenta.

¹ Archives of Otology, 1883, vol. xii., Nos. 3 and 4, p. 118.

² On the Animal and Vegetable Parasites of the Human Body. Translated by E. Lankester, London, 1857, p. 226.

³ Loc. cit., p. 260.

From this arrangement Micheli conceived the name *Aspergillus* (*Aspersorio*, holy-water sprinkler).¹

"In regard to the position of Pacini's fungus in the system, I should not, after my observations of Pacini's drawings, have placed it with *Aspergillus*, as Robin did, but associated it with Sluyter's *Mucor mucedo*, . . . so long as we in general allow that every observer actually observes, and has given drawings true to nature. The difference between *Aspergillus* and *Mucor mucedo* consists for the present in the dissimilar form of the so-called placenta and the filamentary radiated or homogeneous light simple ring forming the periphery of the capitulum, and these are possibly only differences in the age and maturity of the individual specimen."²

See, also, quotation under *Aspergillus nigrescens* above.

III. *Aspergillus flavus* Brefeld is by some supposed to be identical with *Aspergillus flavescens* Wreden.

IV. *Aspergillus glaucus*, supposed by some to be *Aspergillus flavus*.

V. *Sterigmatocystis antacustica* Van Tieghem, supposed by F. Siebenmann to be *Aspergillus niger*.

VI. *Aspergillus flavescens* Wreden, supposed by some to be *Aspergillus flavus*.

VII. *Aspergillus nigricans*, similar to *Aspergillus niger*.

VIII. *Aspergillus fumigatus* Fresenius, supposed by F. Siebenmann to be identical with Mayer's aural fungus, called *Aspergillus nigrescens* by Robin, and *Mucor mucedo* by Küchenmeister.

IX. to XVIII. inclusive, Hagen's and Hallier's, rejected by Wreden because they were not fructifying within the ear and were not pathogenic.³ They were developed on potato, apple, etc., outside the ear, and hence are termed "potato and apple fungi" by Wreden.⁴

XIX. *Stemphylium polymorphum* Bon, supposed by F. Siebenmann to be identical with *Verticillium graphii* Harz-Bezold and with *Trichothecium roseum* Steudener.

XX. *Graphium penicilloides* Corda (?). F. Siebenmann surmises "that the *graphium* is not a mould *sui generis*, but only a stem-formation of the fruit-bearers of *Verticillium*."⁵ See *Verticillium graphii* Harz-Bezold, *Trichothecium roseum* Steudener, and *Stemphylium polymorphum* Bon.

XXI. *Trichothecium roseum* Link, supposed by F. Siebenmann to be identical with *Verticillium graphii* Harz-Bezold and with *Stemphylium polymorphum* Bon.

XXII. *Mucor mucedo* seu *fuscus* Fresenius, supposed by Siebenmann to be *Mucor corymbifer* Lichtheim.⁶

¹ Loc. cit., p. 261.

² Loc. cit., p. 262.

³ Archives of Ophthalmology and Otology, vol. iv., No. 1, pp. 102-114.

⁴ Archives of Ophthalmology and Otology, vol. iv., No. 1, pp. 105-112.

⁵ Archives of Otology, vol. xviii., Nos. 3 and 4, p. 259.

⁶ Archives of Otology, 1889, vol. xviii., Nos. 3 and 4, pp. 260-262.

XXIII. *Aspergillus microsporus* Hallier, considered doubtful by R. Wreden.¹

XXIV. *Otomyces purpureus* Woronin, of Wreden and Swan M. Burnett, supposed by them to be "the ascomycete or perithecial fruit of *Penicillium* or *Aspergillus*," "the most fully developed or ascomycete form of *Aspergillus nigricans*." F. Siebenmann,² however, holds that the original description does not coincide with De Bary's *perithecium*, nor with other *sclerotia* of *Aspergillus niger* Wilhelm and Van Tieghem; that the conditions are unfavorable for the formation of *asei*; that the fungus resembles blood-stained *Aspergillus fumigatus*; and that it is probably identical with *Aspergillus nidulans*, as also is perhaps *Aspergillus rubens*, below. The fungus under consideration has been called *Aspergillus ascophora purpureus*.

XXV. *Ascophora elegans* and

XXVI. *Ascophora mucedo* Schenck, with *Mucor mucedo* seu *fuscus* Fresenius, above, are suspected of being identical with *Mucor corymbifer* Lichtheim.

XXVII. *Mucor corymbifer* Lichtheim, supposed to be identical with the *Ascophora* of Schenck and *Mucor mucedo* seu *fuscus* Fresenius, above.

XXVIII. *Eurotium malignum* Lindt, said by F. Siebenmann to resemble *Aspergillus fumigatus* with perithecia.

XXIX. *Penicillium glaucum*, bastard form. Wreden holds that this is contradicted by the diagram which accompanies the report of the case.³ F. Siebenmann suggests a critical comparison between this and *Aspergillus nidulans*.

XXX. *Penicillium minimum* Siebenmann, F. Siebenmann thinks, although closely resembling *Penicillium glaucum*, to have characteristics that distinguish it.

XXXI. *Aspergillus rubens* J. O. Green, suspected by F. Siebenmann of being identical with *Otomyces purpureus* Wreden and *Aspergillus nidulans* Eidam.

XXXII. *Verticillium graphii* Harz-Bezold is by F. Siebenmann considered identical with *Stemphylium polymorphum* Bon, and *Trichothecium roseum* Stendener. This is the fungus "of whose fruit-bearers" *Graphium*, above, is by F. Siebenmann thought to be "a stem-formation." [Harz-Bezold.]

XXXIII. *Mucor septatus* Bezold, "another noteworthy, vigorous mucorinea, not identical with any of the known species"—"bears a striking resemblance to *Mucor rhiziformis* Lichtheim."⁴

XXXIV. *Aspergillus nidulans* Eidam-Lindt, supposed by F. Sieben-

¹ Archives of Ophthalmology and Otology, 1874, vol. iv., No. 1, p. 98.

² Archives of Otology, vol. xii., Nos. 3 and 4, p. 193. Compare vol. xviii., Nos. 3 and 4, p. 255.

³ Archives of Ophthalmology and Otology, vol. iv., No. 1, pp. 94, 119.

⁴ Archives of Otology, vol. xviii., Nos. 3 and 4, p. 264.

mann to be identical with *Otomyces purpureus* Wreden and *Aspergillus rubens* Green.¹ F. Siebenmann suggests the critical comparison of *Aspergillus nidulans* Eidam-Lindt with the bastard form of *Penicillium* Blake.

This will serve to give the reader some idea of the conflict of opinion in the literature from which the preceding synopsis was made. To harmonize the statements and adjudicate the differences of opinion among such eminent observers is a task which the writer would not presume to attempt.

Such being the moulds which grow within the human ear, let us turn our attention to their different modes of growth and reproduction, and consider them first as exemplified in the *Mucorini*, or *black moulds*.

When a spore of one of the *Mucorini*—which are facultative—falls, in conditions favorable to its growth, upon nourishing soil, it first puts forth one, two, or more very slender thread-like processes of protoplasm (*hyphæ*), which grow to a relatively great length, abundantly branching, until, through their ramification, multiplication, extension, and intermingling, there is formed a web, membrane, or stratum (*mycelium*) like felt or blotting-paper, close to or penetrating the tissues of its nutrient medium. The individual plants composing this mycelium—each, at first, one continuous mass of protoplasm enclosed within a hyaline membrane—soon become divided, at irregular intervals, by transverse septa continuous with the investing hyaline membrane. From the mycelium, now composed of elongated cells, branches dip down into the nutrient medium (*submerged hyphæ*). This constitutes the vegetative stage. (Fig. 17.) Fructification and reproduction of moulds take

place in one or both of two ways, termed the *asexual* and the *sexual*. In the asexual, hyphæ grow erect from the mycelium, and upon these aerial or fructiferous hyphæ, so called, the germinal elements, reproductive cells, seed, or *spores* are produced. (Fig. 17.) In the *Mucor mucedo*, for example, spore-formation takes place as follows: the aerial hyphæ, one continuous mass of protoplasm enclosed within a hyaline membrane, become somewhat enlarged at their distal extremity, near which forms a transverse septum continuous with the investing hyaline membrane. (Fig. 18, *a*.) The

FIG. 17.

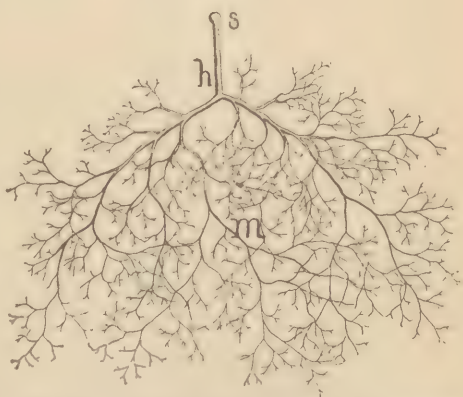


Diagram representing the growth of the mycelium (*m*), aerial fructiferous hypha (*h*), and sporangium (*s*) of *Mucor mucedo*. (Modification, after Prantl.)

¹ See, also, Archives of Otolgy, vol. xviii., Nos. 3 and 4, p. 255.

terminal segments continue to enlarge spheroidally, encroached upon by the protoplasmic fruit-stalks, or aerial hyphæ (Fig. 18, *b*), and gradually becoming spherical (*sporangia*), the hyphæ still further encroaching (*columellæ*); when, finally, the protoplasm of the sporangia becomes divided and subdivided into innumerable minute spherical masses (*spores*), each invested with a hyaline membrane. (Fig. 18, *c*.) In some

FIG. 18.

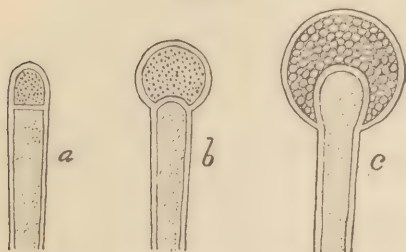


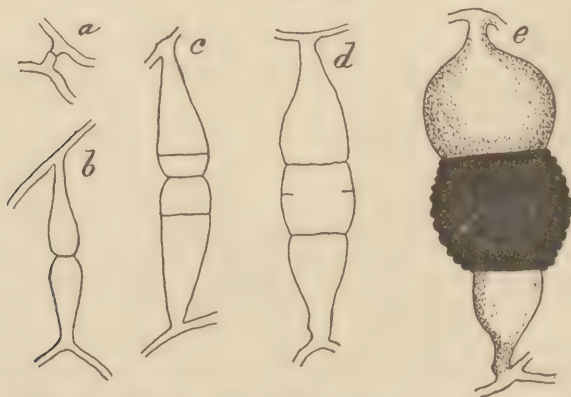
Diagram representing the stages of formation of the sporangium of *Mucor mucedo*. (Modification, after Bessey.)—*a*, distal extremity of aerial fructiferous hypha, after its segmentation; *b*, its enlargement, with bulging of septum thereinto; *c*, fully-developed sporangium, with its spore-formation, and columellar encroachment of fruit-stalk.

moulds the aerial hyphæ divide into two or more branches, upon whose extremities form single sporangia. In others, whose hyphæ are not branched, the sporangium contains but a single spore,—a process resembling somewhat conidial spore-formation.

Dissemination of mature spores follows auto-absorption, rupture, or fissure of the sporangial wall, or peridium, so to speak. If uninjured, the spores may retain their germinal vitality for a long time. If brought into contact with a nutrient medium, under favorable conditions, they may germinate, as their parents did, by putting forth hyphæ, forming mycelium anew.

Sometimes, but infrequently, a portion of the protoplasmic mass of a

FIG. 19.



Formation of a zygospore in sexual reproduction of *Mucor stolonifer*. (After De Bary.)—*a*, conjunction of the lateral branches of two adjacent hyphæ; *b*, enlargement of conjoined branches; *c*, formation of partition near conjoined end of each branch; *d*, blending of terminal segments into one protoplasmic cell, following absorption of their dividing membranes; *e*, fully-developed zygospore ($\times 90$).

hypha becomes transformed into a germinal cell (*chlamydospore*). When this occurs, as it occasionally does, at the extremity of an aerial hypha, it is apt, unless recognized and understood, to mislead or confound the observer, owing to its resemblance to one stage of conidial spore-formation.

Asexual reproduction may be repeated for successive generations indefinitely, or it may be interrupted at intervals by the sexual, which takes place as follows. Two adjacent branches of mycelium put forth, from their contraposed surfaces, each a twig, which, meeting at their extremities, become conjoined. (Fig. 19, *a*.) The terminal portion of each twig then enlarges, while at the same time it becomes segmented from the rest by a transverse septum continuous with the investing hyaline membrane. (Fig. 19, *c*.) Further enlargement of these terminal segments, together with absorption of their dividing membranes, is followed by the blending of these two protoplasmic cells into one,—the essential zygosporic mass. (Fig. 19, *d*.) The formation of a thick, opaque protecting membrane about this mass completes the *zygospore*, or *resting-spore* (Fig. 19, *e*), so called from the fact that the germinal elements therein contained usually retain in quiescence their specific functional potency for a very long period before being themselves discharged. After a suitable period of rest, if placed in a moist atmosphere, the zygospore puts forth a single hypha, which bears a sporangium (of the asexual type). Mycelium-forming hyphæ never grow from the zygospore; they are the offshoot of the sporangium only.

In the growth and reproduction of the *Ascomycetes* the process is somewhat different. When a spore of one of the *Ascomycetes*, in conditions favorable to its growth, falls upon nourishing soil, it puts forth hyphæ which form mycelium, after the manner of a spore of one of the *Mucorini* described above. Now, however, processes from this mycelium shoot upward, erect (fructiferous aerial hyphæ), upon which reproduction takes place in one of several ways. For instance, in the *Eurotia*, which are saprophytes, asexual reproduction is characterized by the growth, upon the distal end of the fructiferous aerial hyphæ, of a bulbar enlargement closely studded with radiating rod-like *sterigmata* (Fig. 20, I., *st*), afterwards transformed into strings of conidia. (Fig. 20, II., *sp*.) The manner of transformation of the sterigmata shafts of protoplasm into strings of conidia is beautifully illustrated by the asexual reproduction of *Spharotheca pannosa*, in which the erect aerial hypha becomes subdivided, at regular intervals, by transverse septa continuous with the investing hyaline membrane, into cells elliptical in form but flattened at the ends. The extreme segment first becomes rounded, followed by the others in succession, thus producing the strings of elliptical or spherical cells (*conidia*) (Fig. 21), which, when mature, drop off. When such spores or conidia germinate and vegetate they form mycelium. Asexual reproduction may be repeated for generations indefinitely, or until the death of the tissue upon which the parasite is feeding, when the sexual reproduction begins, as a rule. Or the asexual may be very shortly interrupted by the sexual reproduction, in which process the spores are formed in sacs (*asci*) characteristic of the *Ascomycetes*, each ascus containing from two to eight spores (*ascospores*). The asci are enclosed in a wall of cells (*perithecium*), the whole forming the *sporocarp*, which is formed as follows (Fig. 20). The terminal extremity of a branch of mycelium coils,

corkscrew fashion, the turns approximated more and more closely as they approach the end, until near it they unite and form a hollow screw, as it

FIG. 20.



EUROTIUM REPENS. (After De Bary and Woronin.)—I., a portion of the plant, consisting of mycelium (*m*); a fructiferous aerial hypha (*h*); a sporangium which has shed its spores, but remains still covered with radiating sterigmata (*st*); and spirally-coiled hyphae (*sp*), of which one has already formed a complete carpogonium (*c*). II., mycelium (*m*), fructiferous aerial hypha (*h*), bearing upon its top a full-blown sporangium still covered with strings of conidia or spores (*sp*). III., fructiferous aerial hypha (*h*), spirally coiled, bearing the female element, a perfect carpogonium (*c*), from the bottom of which has sprung and is climbing the male element, an antheridium (*a*). IV. (parts and lettering corresponding to those of III.), the (male) antheridium (*a*) is just entering the (female) carpogonium (*c*) to impregnate it. V., after impregnation of the carpogonium (*c*), enveloping branches (*e, e, e*) growing out from its base, clinging to the carpogonium, and growing upward and over to finally surround it; then becoming septate. VI., mature sporocarp (*sc*).

were, of hyphal protoplasm, whose threads are transversely divided at intervals by septa continuous with the investing hyaline membrane. This spiral body constitutes the female organ of generation (*carpogonium*). (Fig. 20, I., *c*.) From the bottom of the carpogonium springs a protoplasmic branch, the male organ of generation (*antheridium*). (Fig. 20, III., *a*.) The antheridium grows upward, adhering closely to the carpogonium, until it passes over the top and touches the interior of the carpogonium, which it thus impregnates. (Fig. 20, IV.) Then from the base of the carpogonium spring out hyphae which grow upward, closely approximated and clinging to the carpogonium (the protecting cells of the perithecia). (Fig. 20, V., *e, e, e*.) After these entirely cover the carpogonium, they become divided into several cells each by transverse septa continuous with the investing hyaline membrane, which gives the

perithecia of the sporocarp a cellular appearance. (Fig. 20, VI., *sc*.) "In the mean time, from the cells of the carpogonium branches bud out

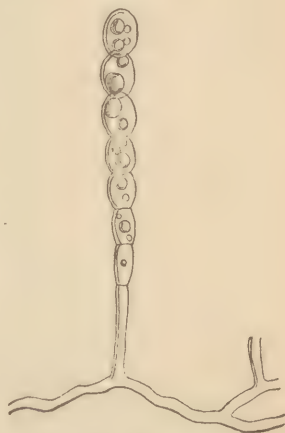
and penetrate the surrounding parenchyma, and finally produce eight-spored asci on their extremities; after a time the asci are dissolved, and the sporocarp, now of a sulphur-yellow color, contains only loose ascospores intermingled with the débris of the broken-up asci and parenchyma.”¹

Another mode of sexual reproduction of the *Ascomycetes*, as exemplified in the order *Perisporaceæ* (or *Erysiphaceæ*) and in the species *Sphærotheca* in particular, is this. Two branches of mycelium (hyphæ) which have remained in contact begin to swell at the point of contact, and each sends forth a branch; that of one assuming, gradually, an oval (carpogonium), the other a much more elongated form (antheridium), both becoming at the same time divided by septa continuous with the investing hyaline membrane, the septum of the carpogonium being near its branch, that of the antheridium near its end. (Fig. 22, I.) The antheridium, which has by this time climbed to the top of the carpogonium, impregnates it by contact with its tip; fertilization being manifested by the budding of eight or ten branches from around the stem, just below the carpogonium, which, clinging to the carpogonium, grow upward in contact with each other (Fig. 22, II.) until they wholly enclose it, thus forming the perithecial coat. (Fig. 22, III.) These protecting cells become divided at intervals by transverse septa continuous with their investing hyaline membrane, thus rendering the perithecium a cellular structure. (Fig. 22, III. and IV.) A division now takes place between the outer and inner portions of the carpogonium, whereby a layer of cells is left as a lining to the perithecium, while the contained portion forms one or several asci, in each of which form from two to eight ascospores. As the perithecium becomes darker and harder, from the cells of its outer layer there grow long branches, slender, septate, and of a shape peculiar to the species. After an extended period of repose, the perithecium ruptures and releases its ascus or asci, which in turn, by rupture, permit the escape of their contents, the spores. (Fig. 22, IV.)

Usually, there are formed “other organs, which bear small spore-like bodies, but whose function is not certainly known, . . . known as *pycnidia*, . . . clavate, ovate, or nearly spherical in shape” (C. E. Bessey).² Within their cavities are contained the *pycnidio-spores*.

This, then, is the behavior of moulds within the ear, the exciting cause of the disease; and the reader will find familiarity with their morphological

FIG. 21.

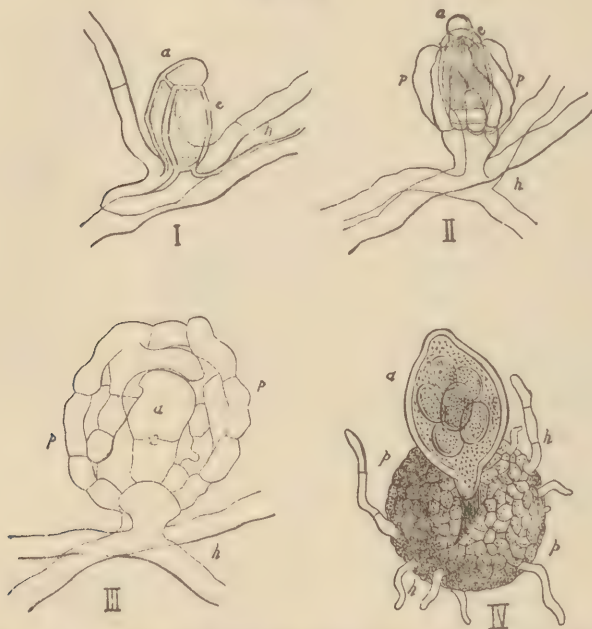
Conidiiferous hypha of *Sphærotheca pannosa*. (After Tulasne.)

¹ Charles E. Bessey, "Botany," Henry Holt & Co., New York, 1889, p. 283.

² Loc. cit., p. 281.

features, mentioned above, indispensable to a clear comprehension of the phenomena of microscopic examination of these moulds.

FIG. 22.



SPHÆROTHECÆ. (I., II., III., after De Bary and Woronin; IV., after Tulasne.)—I., sexual organs of *Sphærotheca pannosa*; h, fructiferous hyphæ; c, carpogonium (female element); a, antheridium (male element). II., the same, after fecundation; pp, the perithecial cells growing from below and surrounding c, the carpogonium, and a, the antheridium; all supported by h, the fructiferous hyphæ. III., sectional view of young sporocarp of *Sphærotheca Castagnei*; c, the carpogonium, including a, the ascus, surrounded by pp, the perithecial cells; all supported by h, the fructiferous hyphæ. IV., mature sporocarp of *Sphærotheca pannosa*; hh, hypha-like outgrowths from pp, the perithecial cells. A rupture of the perithecium has given exit to a, the ascus, which here is single and seems to contain but six spores.

Pathology.—The pathological features of the disease are first a hyperæmia of the blood-vessels of the membrana tympani, followed by congestion and tumefaction of the cutis of the membrana and of the neighboring wall of the canal. As the mycelium or pseudo-membrane forms upon the surface, the epidermis becomes degenerated and smothered, or starved, as it were; and the parasite may attack it directly or send its mycelium into the tissue-interspaces. A separation of the outer tissues then takes place, leaving an exposed and inflamed corium, with serous exudation, sometimes quite abundant. There is now a brief period of suspended activity. The submerged hyphæ and the fresh spores may renew their destructive work upon the exposed membrane and penetrate it; and the drum-head may be perforated, and may break down. The tympanum may then be invaded by the mould, which has been known to flourish actively upon the mucous membrane of the middle-ear tract. As a rule, the inflammation and the growth of the parasite begin at the drum-head and gradually extend outward, until often the entire meatus is involved; or, again, the mould may,

after a time, limit its growth to a circumscribed portion of the wall of the external auditory canal, as in the cases of *Ascophora elegans* and *Trichothecium roseum* reported by Von Tröltzsch and Steudener.

Diagnosis.—The repeated shedding of the pseudo-membrane and epidermis is usually attended by a brief cessation of the more acute symptoms of the inflammation, but followed by a diffuse inflammation, perhaps eczematous, of the canal wall. Each cessation of the more acute symptoms, after the pseudo-membrane is shed, is followed by a more severe recurrence of all the symptoms and other phenomena. The separation of the pseudo-membrane from time to time becomes attended with more and more pronounced phenomena; and as the inflammation persists, the tissues still further exhausted and invaded by the parasite, the morbid process becomes more and more firmly established. At best the tissues are left somewhat exhausted and subsequently liable to this or other disease.

The rational symptoms and physical signs render the diagnosis of this disease by the careful observer one of no special difficulty.

Rational Symptoms.—The rational symptoms, on the one hand, are such as would naturally be expected with the pathological process just described, complicated as it is by the presence of a foreign substance upon the drum-head and other parts involved in the inflammation; but the symptoms alone are not pathognomonic. They “may be briefly given as stinging, itching, dulness of hearing, some pain, and a watery but scanty discharge. The patient may finally complain of great pain and deafness if the membrana tympani should become inflamed” (C. H. Burnett).¹ A feeling of stuffiness as if the ear were plugged with cotton, a “drawn feeling,” as it were, on the corresponding side of the head, is quite frequently complained of in this disease.

Physical Symptoms.—On the other hand, the physical signs, macroscopical and microscopical, seem almost unmistakable. In the first place, on illuminating and inspecting the fundus of the canal—if the case present early in the disease—we may see the injection of the myringal plexus of blood-vessels, and the veil-like plaque of mycelium forming upon the drum-head. Later we may see the inner end or sometimes the whole of the wall of the canal and the drum-head covered with a substance resembling wet newspaper or dirty blotting-paper, with small raised spots of a black, brown, green, or yellow color. This is often glazed by the serous effusion passing over it, which is sometimes so profuse as to fill the canal. The pseudo-membrane may be mistaken for a foreign body, laminated epithelial plug (*keratosis obturans*), croupous or diphtheritic otitis externa, or cerumen,—from which it may be distinguished as explained below. If at a suitable stage of the inflammation the lardaceous pseudo-membrane be removed, we can readily recognize the raw tissue of the exposed corium, and, having first dried it with a brush of absorbent cotton-wool, may see

¹ *Aspergillus in the Human Ear, with Report of Eleven Cases.* Medical and Surgical Reporter, Philadelphia, 1889, vol. lxi., No. 20, p. 539.

the recurrence of the profuse exudation. If, however, not waiting for the proper condition, when the pseudo-membrane is lying loosely upon the membrane of the canal above its normal plane, we forcibly remove it, the underlying surface is apt to bleed, while the aggravation consequent upon this maltreatment will be manifested by intensification of the symptoms and by more distinct physical signs. In the early stage the thin glue-like or starch-like appearance of the mycelium submerged in serous discharge, and the resemblance between the matured plant within the ear and a wad of wet newspaper, are so strikingly characteristic as to be almost unmistakable. Incidentally, mention may be made of an experience of the writer, where upon one occasion, having removed such an object from the ear of a patient, he was amused to find, quite unexpectedly, that instead of an otomyces it was a genuine "wad of wet newspaper."

A differential diagnosis from croupous or diphtheritic inflammation of the canal may be made usually from the symptomatology alone. While in otomyces, on the one hand, the symptoms are comparatively slight and without constitutional disturbance, in diphtheritic otitis externa, on the other, they are usually marked, and attended by the severe constitutional disturbance characteristic of the disease. Moreover, microscopic examination would at once discover the presence of the mould in the one case, and in the other with proper care either the streptococcus of Prudden,¹ the bacillus of Löffler,² or both.

Cerumen is distinguishable from it by its dark-brownish color, its greater solidity, lustre, and dryness; by the absence of such pain and inflammation as usually attend otomycosis; and by the fact that it readily disintegrates or dissolves in warm water or glycerin, unlike the mycelial cast of otomycosis.

The laminated epithelial plug, or *keratosis obturans*, is not so moist as *otomycelium*. It consists of layer after layer of epithelial tissue, and, though somewhat similar to the otomycelial casts, is readily distinguishable on microscopic examination.

As said before, the conclusive test is that of microscopic examination of a portion of the growth. The specimen removed, if not intended for culture, should first be freed of air by dipping in dilute alcohol; afterwards treated in a weak alkaline solution (of ammoniac or potassic hydrate, for example) until the shrivelled hyphæ regain their normal proportions; then either dried or mounted in distilled water, plain or carbolized, alcohol and water, etc.; and at once examined with a power not weaker than $\frac{300}{1}$, which will give satisfactory results for diagnostic purposes. The anatomical features of the plant as it is—the *spores*, *mycelium*, *submerged* and *aerial*

¹ "On the Etiology of Diphtheria. An Experimental Study," American Journal of the Medical Sciences, May, 1889, and "Studies on the Etiology of Diphtheria," second series, Medical Record, New York, April 18, 1891.

² Mittheilungen a. d. Kaiserlichen Gesundheitsamte, Bd. ii., 1884; and Deutsche Militärärztliche Zeitschrift, Bd. xv., S. 353.

hyphæ, *fruit*, and *residua*, together with the enmeshed degenerated tissue—are readily distinguishable thus; and if these are specially characteristic, mycological identification and classification can be made at once. But frequently they are not so, and the physiological features of the growth—especially the phenomena of reproduction—are not sufficiently marked to justify a positive statement as to the identity of the mould; when artificial culture should be made. This may be done in one of several ways, briefly described as follows:

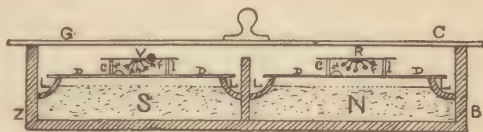
Extreme care must be exercised to prevent the intrusion of foreign moulds; and every part of the apparatus and instrumentarium should be sterilized before using.

The portion of the prepared specimen removed may be sown upon ordinary horse-dung and kept moist under a bell-glass. Portions of the fresh mould will soon flourish, and can then be removed for examination or further culture. Some of the spores of this new growth may be sown on moistened fresh bread, and kept moist under a bell-glass.

A sterilized test-tube containing agar-agar as a culture medium is quite convenient and serviceable for these investigations. If a portion of the growth be removed from the ear with a sterilized instrument and planted within the culture medium of such apparatus, the investigations can be made with little inconvenience.

"Cell-cultures," so called, are the most satisfactory. The essential apparatus therefor consists of a glass slide to which has been cemented a ring, four or five millimetres high, of glass, metal, or rubber, over which fits accurately an ordinary cover-glass. In addition to this, Van Tieghem and Le Monnier have recommended a "growing-box,"—a zinc or tin box with ledges for support of the cell-slides. In the bottom of the box is placed moistened sand. After the cell-slides are properly mounted on the ledges, the box is covered with a plate of glass, having preferably a knob or handle. (Fig. 23.) When a specimen is to be mounted, there is first placed on the sterilized cover-glass a small drop of a solution composed of

FIG. 23.



Cell-culture apparatus, devised by Van Tieghem and Le Monnier,—sectional view,—modification of that of Bessey. Z B, zinc growing-box; L, L, L, L, immovable ledges for supporting the glass slides D D, D D; S, N, sand, moistened; e l, e l, rings of rubber, metal, or glass cemented to the glass slides; V, R, cover-glasses, laid upon the oil- or vaseline-tipped upper edge of the rings, thus completing the cell; W, W, drop of water; F, F, mould growing on the nutrient liquid of the cover-glass.

"Calcium nitrate, four parts;
Potassium phosphate, one part;
Magnesium sulphate, one part;
Potassium nitrite, one part;
Distilled water, seven hundred parts;
Sugar—sometimes omitted—seven parts."

Or a drop of "boiled and filtered orange-juice," or of a "decoction of horse-dung, boiled and filtered, may be used."¹

Now, this infected cover-glass is placed, culture medium downward, upon the top of the cell-ring, whose upper edge has previously been covered with the thinnest possible coating of vaseline or sterilized oil; and it is customary to place beforehand a drop or two of water on the floor of the cell, to keep its atmosphere moist. The cell-slide may now be protected by a bell-glass, or, if a growing-box be at hand, placed upon the supporting-ledge above the moist sand, and the glass cover then replaced (Fig. 23). Every detail of morphology in the growing plant can now be observed by simply transferring the cell to the stage of the microscope, replacing it when not under observation. The expense and care requisite for this method of investigation are more than repaid by the convenience, accuracy, and other advantages of observation thereby insured.

Access to the works universally recognized as authority on mycology, and to specimens herein referred to, was afforded the writer through the courtesy of Professors Trelease and Webber, of the Shaw School of Botany, Washington University, St. Louis, who kindly advised him in their selection. The writer is indebted to Mr. Albert Ruckstuhl, of St. Louis, for his valuable assistance in the preparation of illustrations for this article.

Prognosis.—The prognosis as regards recovery is good; cure, under proper treatment, being the rule. There is a probability of recurrence if the conditions which predisposed to the present attack are allowed to persist after cure.

The duration of the disease depends largely upon the habits and surroundings of the patient, upon his health, upon the preceding integrity of his membrana tympani, and upon the therapeutic measures employed in the management of the case. A single application of the proper remedy at the proper time may effect a permanent cure.²

If perforation of the membrana tympani has occurred and the fungus is growing within the middle-ear tract, cure is more difficult, and thereafter measures looking to the restitution of the lost membrane should be instituted; else deafness ensues, and recurrence of otomycosis is probable.

Treatment.—Treatment consists in checking the growth of and removing the mould, and allaying inflammation and irritation of the tissues. In most cases careful syringing with warm sterilized water, or water and alcohol, will bring away most of the growth; while the part remaining—usually attached intimately to the tissues by submerged hyphæ—may be removed by gently wiping with a brush of cotton-wool rolled upon the end of a cotton-carrier or silver probe. The latter procedure is inadvisable, as a rule, in view of its possible irritating influence upon the prevailing in-

¹ Charles E. Bessey, op. cit., p. 240.

² *E.g.*, C. H. Burnett, Medical and Surgical Reporter, Philadelphia, 1889, vol. lxi., No. 20, pp. 541, 542.

flammation. It is preferable to dress the parts with the germicidal preparation selected for the case for a little while longer, when the remainder of the growth will perish, and can then be readily removed by syringing as advised above. In exceptional cases, however, instrumental interference becomes necessary for removal of the growth. The treatment should be administered in every case by the physician himself, inasmuch as the patient rarely succeeds in attempts to syringe away the growth, while if another layman should attempt it for him he might do serious and irreparable damage to the ear. Moreover, the patient may resort to it too often, through a natural desire for the temporary relief from discomfort or pain thereby afforded, and a severe and obstinate eczema may result.

The medicinal agents recommended for the destruction of this growth are almost as numerous as the individuals who recommend them. It seems best to the writer to make mention of those only which are historical, so to speak, or recommended by the highest authorities upon this subject. And first it may be said that the use of medicaments in powdered form appears to be preferable to that in the liquid form, since, as a rule, there is already liquid in the discharges of the tissues more than sufficient to act as a solvent for the powders, which are, as well, more drying. An exception, however, should be made of fluid preparations whose active ingredient is alcohol. In some cases this agent, diluted to a degree which robs it of its painful power, seems to desiccate and destroy the growth, and to act beneficially upon the inflamed tissues, especially if they be granulated. Among other advantages claimed for alcoholic treatment are that alcohol readily penetrates the crevices, furrows, and fissures of the skin, and that by rapid evaporation it lowers the local temperature. Authorities who prefer it advise the previous removal of fats, etc., from the ear by syringing with an alkaline solution. The proper use of alcohol for this purpose is briefly taught by Küchenmeister¹ in the following sentence: "It all depends upon the greater or less dilution of the alcohol, so as to avoid irritation and pain; and, further, on the degree of dilution, so as not to destroy the parasitocidal effect of the remedy." Siebenmann² and Bezold suggested the addition of two per cent. of salicylic acid to the alcohol, which was pronounced wholly satisfactory in their experience.

Among powders, none has yielded as good results as that recommended by Dr. Charles H. Burnett, of Philadelphia, which consists of chinoline salicylate one part and boric acid eight to sixteen parts.³ This preparation is convenient of application, and painless, prompt, and efficient. A single application, as stated above, has been known to effect a permanent cure. Besides having power to destroy the mould, it is efficient in killing the micro-organisms of suppuration. It was for suppurative inflammation

¹ Loc. cit., p. 40.

² Archives of Otology, New York, 1883, vol. xii., Nos. 3 and 4.

³ Medical and Surgical Reporter, Philadelphia, November 16, 1889, vol. lxi., No. 20, pp. 539-43.

of the ear that Dr. Burnett first recommended chinoline to the profession in April, 1882,¹ and again in October of the same year.² This compound powder stands *facile princeps* among remedies for otomycosis; and the practitioner who fails to employ it in the treatment of this disease surely misses his opportunity of making a rapid, safe, and painless cure.

For inflammation following the destruction and removal of the growth, the powder just recommended is excellent. Another good remedy is that of Hinton:

℞ Liq. plumbi subacetat, ℥xx;
Acid. acet. dilut., ℥vi;
Liq. opii sedativi, ℥xx;
Aque destillat. q. s. ad f ʒi.—M.

Sig.—Drop ten drops, warmed, into the ear, as directed.

C. H. Burnett speaks highly of this for use “in any discharge arising from the walls of the external auditory canal.”³

If the inflammation be eczematous, we may dust on a powder composed of equal parts of starch and oxide of zinc.

Samuel Theobald, of Baltimore, says that zinc oxide rubbed up with vaseline, with the addition of a little balsam of Peru, is efficient in otitis externa diffusa, “especially in those moist inflammations attended by slight discharge without perforation of the drum-head, which I have met with oftenest in scrofulous subjects.”⁴ He says, in the same connection, that he had recently obtained better results with a finely triturated powder composed of equal parts of zinc oxide and boric acid; and that while boric acid was germicidal, yet in otomycosis, used alone it was not as efficient as when joined with zinc oxide, which dried up the discharges.

Among other well-known remedies, with their eminent commendators, are the following: potassium permanganate, one to two per cent.: Von Trölsch; solutions of tannin, bichloride of mercury, lead, carbolic acid, carbonate of soda, hypochlorite of lime, gr. ii to ʒi freshly prepared, chlorinated lime, one to three hundred: Wreden; argentic nitrate, gr. x-c to ʒi; alcoholic solution of tannin, one to fifty; chlorine water, bromine water, iodine water: Wreden; permanganate of potassium, strong solution: Siebenmann, who joins Bezold in praising salicylic acid in alcohol, two to four per cent; sodium subsulphate, eighteen to three hundred: C. H. Burnett; powdered magnesium and salicylic acid: C. H. Burnett; solution of sodium salicylate, gr. xx to ʒi, after saturated solution of salicylic acid had proved ineffectual: Strawbridge; alcohol only: Politzer, Hassenstein; acetate of lead in water, fifteen to three thousand: Pacini; acetate of lead in water, ten to three thousand: Kramer; carbolic acid and glycerin, three

¹ American Journal of Otology, April, 1882, vol. iv., No. 2, p. 122.

² American Journal of Otology, October, 1882, vol. iv., No. 4, pp. 264, 265.

³ American Journal of Otology, April, 1879.

⁴ American Journal of Otology, 1881, vol. iii., No. 2, p. 119.

per cent. : Lucae ; strong solution of argentic nitrate : Roosa ; poppy fomentation, water, and glycerin : Grove ; boric acid is rejected by Siebenmann. This list might be extended indefinitely ; but these will give the reader a fair idea of the diversity of remedies recommended for otomycosis.

The salicylate of chinoline and boric acid, one to eight to sixteen, will probably give best results, and should be tried first. If granulations spring up in the canal wall, they demand treatment such as is suggested under *Otitis Externa Diffusa*, *Otitis Media Purulenta Chronica*, or *Aural Polypi*.

In conclusion, it may be said that the medical profession would reflect greater credit upon its attainments if there were an intelligent effort, on the part of each individual observer of aural moulds, to identify, classify, and if possible preserve dried cultures of them for examination by brother practitioners and by expert mycologists. It is hoped that this paper, with its bibliographical references, may prove of practical assistance in the furtherance of that end.

OTITIS EXTERNA DIFFUSA MALIGNA.

By malignant disease we here mean an inflammation of the external auditory canal characterized by invasion of surrounding tissues, by the property of local reproduction after removal, by the formation of metastases, and by the development of a cachexia.

Varieties.—Malignant disease may develop primarily and in one spot, and subsequently involve all the tissues, of the external auditory canal. Here more frequently it is secondary, usually originating in the auricle, middle ear, or mastoid proper, whence it invades and entirely destroys the canal.

Occurrence.—"Epithelial cancer of the canal," so called, or carcinoma, is rarely found in early life. It may occur in different members of the same family, in the same or different generations ; and it then seems to have an hereditary nature.

Etiology.—It sometimes seems to have been caused directly by some mechanical irritation, such as habitual scratching of the ear with a pin, etc. It may take its origin in a wart, in an ulcer, or sometimes without assignable cause.

Pathology.—It is a growth, a morbid production of tissue consisting of an atypical agglomeration of new elements. In adenoma, on the other hand, the arrangement is typical. The adenoma, however, is apt to become atypical and malignant. In the carcinoma we find two essential elements,—(1) a connective-tissue stroma containing blood-vessels, which in the form of broad and narrow bands divides the tumor into a series of irregular communicating spaces called *alveoli* ; and (2) that which fills these alveoli : cells resembling more or less closely the epithelial cells of the canal, the cells not being intimately connected with the connective-tissue stroma, but simply lying against it. It should be borne in mind that neither the stroma nor the cells alone are characteristic of this cancer, but that it is their peculiar

arrangement in alveoli that characterizes them as epithelioma. The growth may begin in skin or in glandular structure ; as for example in the verruca.

Diagnosis.—There may be itching, gnawing pain in the inflamed part ; headache ; tinnitus aurium, deafness, and other phenomena incident to disturbed functions of the ear ; from the growth, bleeding, or other discharge, sometimes mephitic, sometimes purulent, sometimes serous ; facial paralysis ; exophthalmos ; blindness ; gnawing pain, gradually and steadily increasing unless palliated with anodynes ; and later in the disease, the symptoms due to inflammation and destruction of adjacent parts (in the order of their involvement by the growth). Without drawing an unnecessary and revolting description of the details of a hopeless and ultimately fatal case, it may be stated in general that, with all the phenomena obviously characteristic thereof, the inflammation progresses steadily, destroying as it goes, until, from exhaustion, sepsis, or the invasion of a vital part, the sufferer is relieved of his agony by death.

Differential Diagnosis.—Though very apt to form metastases in the neighboring lymphatics first,—upon which property some practitioners rely in differential diagnosis from syphilis, sarcoma, etc.,—it does not always do so. Hutchinson says, “ Nothing can be more illusory than to teach that enlargement of the lymphatic glands is one of the *features* by which cancer can be distinguished from other local disease. There is no doubt, however, that in any case which comes under observation late, and with enlargement of the glands already existing, we may take this part as important evidence in support of the diagnosis of cancer. Neither in secondary nor tertiary syphilis is it at all common for there to be any implication of the lymphatics.”¹

The cancerous ulcer is difficult to distinguish from the syphilitic. There is, however, as a rule, the following difference. In cancer a distinct growth precedes the ulceration ; in syphilis it is a chronic inflammation only. In cancer there is a well-defined margin to the induration ; in syphilis there is not. In cancer there are almost always sprouting masses on the surface of the ulcer ; in syphilis there are not. While these are the usual and distinguishing features, they are, however, not invariable, and are therefore not conclusive. The best means of differential diagnosis is that of rapid mercurialization by inunction, with internal administration of iodide of potassium, a procedure which will have no appreciable effect upon cancer, while on the other hand it ought within ten or twelve days to make an appreciable change in a syphilide. In cases where examination with the microscope is not conclusively demonstrative, the antisymphilitic treatment should at once be instituted, so that the patient may have the benefit of the doubt and of this test for removing uncertainty in the diagnosis.

Prognosis.—Although, as a rule, this disease is quite malignant, it is sometimes but slightly so ; and it is said that in cases of undoubted cancer

¹ Syphilis, American edition, p. 511.

extirpation has been performed without return of the disease. The bleeding, painful, warty growths of the canal wall, while of suspicious character, need not elicit an unfavorable prognosis, since they can be removed and may never return; as in a case of the writer's, where the growth, after having been twice removed by others within the year preceding, returned, but where, after getting rid of certain sources of reflex aural irritation, the growth was removed successfully, and without reproduction.

Treatment.—If seen early enough, the growth should, in the writer's judgment, be removed. If it return, then the greater portion of the membranous lining of the canal may be taken. If this be beyond the skill of the operator, or if it be contra-indicated, then the growth may be removed with nitric or concentrated lactic acid, electro-cautery, or—and this if there be ulceration and offensive discharge, especially in old or debilitated patients—with a preparation composed as follows:

R Cocaine muriate, ℥ss;
Caustic potash, ℥iiss or more;
Petrolatum, ℥ii.—M.

Sig.—Rub in well with wooden spatula.¹

Before making this application the skin should first be thoroughly cleansed. In applying, use but a small amount, rubbing it in thoroughly. Then from time to time, at the sitting, remove with a cotton-wool brush the tissue destroyed, lest it touch and cauterize healthy tissue. This application is not very painful. The prospect of success, however, in the ordinary case is uncertain at best.

It may be said in general that if a case be treated for palliation only, it must be managed according to the judgment and experience of the medical attendant; and that if radical, surgical or caustic measures fail to check the progress of the disease, *the affected parts must be kept cleansed and aseptic, and the patient kept as free of suffering as possible.*

¹ After Chas. E. Jennings, of London,—“Cancer and its Complications.”

FOREIGN BODIES AND OSSEOUS GROWTHS IN THE EXTERNAL AUDITORY CANAL,

INCLUDING NEOPLASTIC CLOSURE.

BY SIR WILLIAM BARTLETT DALBY. F.R.C.S., M.B. (Cantab.),

Consulting Aural Surgeon to St. George's Hospital, London.

IN writing upon the subject of the removal of foreign bodies from the external auditory canal, it may be said at once, with perfect confidence in the accuracy of the statement, that there are no difficulties worthy of the name, excepting so far as these are created by the attempts at removal unwisely and unhappily made by those who are inexperienced in the examination of the ear. In order to estimate the truth of this proposition, let any one who reads this article endeavor to recall to his mind a single occasion when a foreign body in the ear has caused harm before any attempt has been made to extract it. The fact is that no foreign body is capable of being placed in the external auditory canal in such a position that its removal is difficult to any one who is in the habit of working with reflected light. This will at once become obvious when the shape of the canal is considered. The external portion is capacious and slopes upward; then comes a narrowed part, followed by a second capacious portion, which slopes downward. This, roughly for the present purpose, describes the canal, which, whilst maintaining these broad characteristics, varies immensely in size according to age and individual formation. The first attempt made by the uninitiated invariably ends in the same way,—the foreign body slips into the narrow part, then through the narrow part down the slope and on to the tympanic membrane. Hence the difficulties, dangers, and damages.

With these few words of introduction I will proceed to consider the subject in detail. As might be anticipated, children form the large majority of these patients; they themselves or their companions putting into the orifice of the canal any object at hand, such as a stone from the sea-shore when they are at play, a bead, a pea, a cherry-stone, a piece of slate-pencil, or any object at hand that is capable of being inserted into the orifice of the ear. Before, however, considering the question of removal, it becomes necessary to mention that parents constantly bring children for the purpose

of having some foreign body taken out of the ear when, in truth, there is nothing in the canal, the mistake having arisen from statements made by the child in good faith, but, for all that, erroneous. If such a case is brought before the notice of a competent practitioner, the parents will be told that all is well. Unhappily, it is within the knowledge not only of the present writer, but also of all other aural surgeons of prolonged experience, that, when such a case falls into the hands of those who are not in the habit of examining the ear, the statement is taken for granted, and proceedings are at once commenced to remove from the ear something, the existence and locality of which are in the conjoint imagination of the patient and operator. The result is not difficult to conjecture. After a painful search with a probe, a still more painful attempt to grasp the phantom with forceps, amid the struggles and cries of the child, the tympanic membrane is ruptured, a little blood is observed to issue from the ear, and permanent injury to the hearing is effected.

It is much to be regretted that this has to be mentioned so plainly, but it is so well known to be true that it becomes necessary to do so. That it is no fancy picture may be appreciated when it is mentioned that over and above the experience of many, there are numerous cases on record from the pen of authorities. Indeed, a reference could be made to a lamentable instance in which a search such as has been mentioned was prolonged under chloroform, the last act being an inquest on the child and a post-mortem examination which clearly proved that no foreign body was in the ear. It is, then, not to enunciate a self-evident proposition to lay down an absolute rule that the presence of a foreign body in the ear should be demonstrated beyond a doubt and by means of reflected light before its removal is even considered, much less attempted. The next axiom that may at once be stated is the following,—viz., that if let alone no foreign body can do harm (a solitary exception to this will afterwards be mentioned). The literature of aural surgery is full of examples where foreign bodies have lain in the canal for periods of forty years or more without causing inconvenience or loss of hearing, and have casually been discovered when the ears have come under examination for other reasons. Politzer refers to a piece of slate-pencil which lay in the canal for fifty years, and quotes similar observations by others. Lucac found a cherry-stone that had been in the ear for forty years, Zaufal a cherry-stone for forty-two years, Reine a tooth for forty years, Barr a pea for two years, and Marchal a coral bead for forty-five years. I found a piece of slate-pencil that had been in the ear for thirty years, and a stone for over fifty years. These instances are mentioned to show how absolutely harmless such things are. They are generally found encased in a little ceruminous secretion, and are taken out by the little hook to be mentioned later on when the ear is being cleared previous to an examination of the membrane, which has become necessary from some cause utterly disconnected with the object which is thus casually removed. The word "casually" would very justly imply how

simple was the proceeding, but it will at once be noted that no previous attempts had been made to remove these objects, so that they presented no difficulties.

Treatment.—It was observed by Prof. Politzer, after searching through his record of cases, which extended over many years, that of all the foreign bodies in the ear which he had been called upon to remove, only ten per cent. had previously *not* been interfered with, and probably this would represent the average among specialists in extensive practice. An almost obvious division of cases into two classes will thus suggest itself,—viz., first, the simple and primary cases; second, the difficult and secondary ones, the latter forming the large majority. As to the *first* class, supposing a child to be brought with a foreign body in the ear, and that its presence has been demonstrated by light reflected through the speculum, it will be found to be at the outer portion of the canal. If the confidence of the child can be obtained to the extent that it will sit quite still whilst the speculum is introduced, it will not be necessary to administer an anæsthetic, since no pain nor even discomfort will be induced by any manipulation. If the child is very young and timid, and will not sit still whilst the speculum is being introduced, it should have an anæsthetic, not on account of pain, as there will be none, but because any sudden movement of the child would risk the foreign body's being pushed farther in and beyond the narrowed portion of the canal.

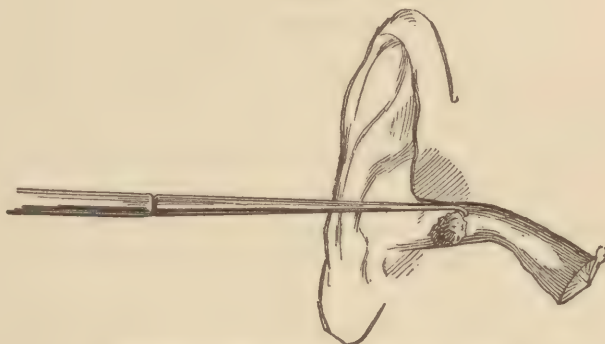
In either case the methods employed will be the same. The size, shape, and surface of the object to be removed will at once suggest the best method. This will be best illustrated by examples. If it be a cherry-stone, a bead, a stone, or similar hard body, whilst light is reflected from a mirror worn on the forehead it is a most simple and easy matter to work it out, so to speak, with the little hook here figured. (Fig. 1.) This instrument is placed above the object and between it and the roof of the canal, and traction made outward. (Fig. 2.) If the object is so large as not to admit of space between it and the roof of the canal, traction must be made by drawing the hook outward, and in the outward movement the point of the hook touching the object rolls it each time nearer to the external opening. I feel bound to say that with this little hook in this the first class of cases I have never had the slightest difficulty in removing anything in a few moments. (It is not, of course, so in the second class.) It is rather important to say this, as I do not wish to depreciate advice which I have constantly seen in hand-books on aural surgery to the effect that syringing should always be first employed; but I still think that those who have the largest experience in these cases will agree with me not only that the method I suggest is extraordinarily easy and successful, but that in these early cases, when no previous attempts have been made, the syringe is very apt, indeed, to first drive the body farther into the canal (even if eventually it washes it out), and surely anything which has the least tendency to do this is to be avoided. I am quite willing to admit that when the case is submitted to one who is

not in the habit of manipulating the ear syringing is the safest and best way of proceeding; also, that very frequently when the object has been pushed beyond the outer part of the external canal in a previous attempt

FIG. 1.

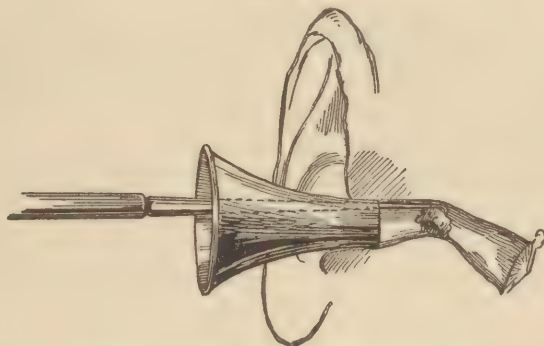


FIG. 2.



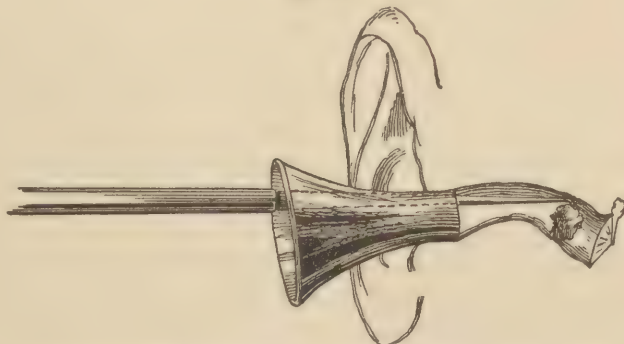
Removal of foreign body in first class of cases.

FIG. 3.



Removal of foreign body in second class of cases.

FIG. 4.



Removal of foreign body in advanced stage in second class of cases.

the syringe is very useful and effective; but at the moment we are dealing with the first class of cases. In the instance of adults in this division there is, of course, no necessity for an anæsthetic; they will remain motionless,

since they are not subjected to pain. Although it has been mentioned that a foreign body of itself causes no inconvenience, the exceptions are found in the case of a bean or pea in the ear, which swells with the moisture, and so requires to be taken away at once, and insects which have crawled into the ear. These latter can always be removed by a syringe. It is very uncommon to meet with these examples, and a few drops of water—which, by the way, patients themselves generally think of—induce the animal to crawl out. I once knew this to happen with an earwig, the only occasion upon which I ever found this animal in the ear.

We now come to the *second* class, which form the ninety per cent.,—viz., those in which the object has been pushed into the ear more or less deeply, in proportion to the enterprise of the operator. Where the attempts have been very limited, the foreign body will be either wedged into the narrow part of the canal (Fig. 3) or will have passed beyond this (Fig. 4); but if the attempts have been prolonged, it will even have been pushed on to the membrane, rupturing it, or possibly even into the tympanum so far as this cavity will permit of entrance. When the body is wedged into the narrow part, so long as there is any swelling or inflammation of the canal, nothing should be done until this has quite subsided after the use of continuous hot fomentations. Then in the case of children an anæsthetic must be given, for it becomes more important than in the first class of cases that there should be no movement of the child.

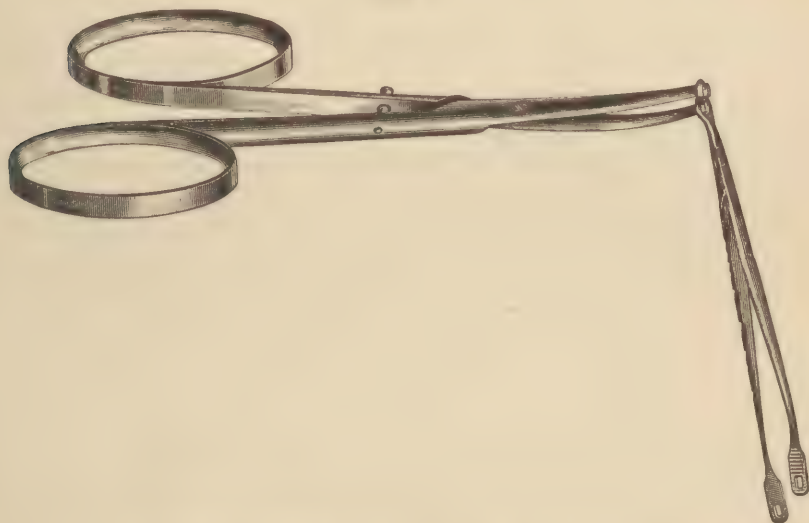
The real difficulties in these cases now begin; what those difficulties are and how they are to be overcome will suggest themselves almost at once so soon as the body is under view. Thus, I once observed in the auditory canal a perfectly round, smooth, imitation pearl, which had slipped off the head of a pin whilst it was inserted into the ear to relieve a temporary itching in the ear. This, in an attempt to remove it, was wedged into the narrow part of the canal, but not broken. I write from recollection of the case. The smooth, slippery, white surface presented itself with no space between it and the canal, no point to lay hold of, no part to grasp. It was just possible to roll it round slightly with an extremely small and very sharp hook, but each revolution brought it no nearer to the opening. I could not say how long I painlessly rolled this round before what I sought came into view,—viz., the hole where it had been joined to the pin. As soon as the point of the hook was in this opening, traction was made, and the bead rolled out.

I mention this case to show how difficult it is to lay down any general rules for the extraction of a foreign body from the ear, and I offer it for the consideration of those writers who every few weeks, in the medical journals, generously give to the world their inventions of a “new instrument for the extraction of foreign bodies from the ear.” To judge from these exhibitions of mechanical genius one might be led to fancy that all foreign bodies were of the same size, shape, angularity, or consistence, and occupied the same position in a canal of unvarying dimensions; until a month or two

later a description of another instrument appears, when each and every one of these conditions would seem to have been different; so that, at last, it may be presumed that each inventor's experience is confined to a very limited number of examples of the condition under notice. The gist of the matter lies in the fact that, when the foreign body has been carefully inspected and its position properly estimated, the best means to employ in extracting it will not be confined to one plan, and the surgeon will naturally select the most suitable instrument for the example before him. This condition being fulfilled, it will matter very little what sort of instrument he uses.

One thing, at least, may be pretty confidently anticipated,—viz., that he will not have a large array of instruments. The little hook referred to, syringes the nozzles of which are so fine as to occupy very little space when in the canal, and a few rectangular forceps (Fig. 5) will make up the collec-

FIG. 5.



Rectangular forceps for removal of foreign bodies from the ear.

tion. Of these forceps it may be said that the portion which goes through the speculum into the canal should be very small and finely made in every respect, considering how very limited may be the canal, and, of course, the speculum. In short, every regard should be given to the extremely limited space, especially when it is remembered that after the forceps are in the canal they have to be opened. The bite of the forceps should also be very sharp, so that if they close over an object there shall be no slipping.

Having pointed out the necessary instruments, when and how should they be employed? It has been explained how, if the foreign body has been previously pushed and wedged into the narrowed part of the canal, it may be drawn outward with the hook, also how syringing might push it farther in. The same applies to the use of forceps, and they should be avoided if the body is in this position, lest in the very act of fixing them

the object should slip down the descending part of the canal, and so the difficulty of extracting be very much increased.

If the object on the first examination is found to have already done this and to be lying in the canal at its distant part, the membrane not having been ruptured, so long as there is no inflammation of the canal and consequently no tumefaction, an attempt may be made to remove it. In all cases it will be understood that no interference should take place till all swelling has subsided under the influence of hot fomentations, and, in cases where there is any pain, leeches in front of the ear before the fomentations. The object being in the position named, the first thing to consider is its size in relation to the narrow part of the canal. If it can readily pass through this passage it may be easily syringed out or drawn out with the hook. If the external surface is rugged and uneven, and if gentle syringing fails to remove the foreign body, it will be quite easy to roll it gradually towards the external opening with the hook; but if its surface is smooth and slippery, like a glass bead or a piece of coral, it will be better to trust entirely to patient syringing. With this sort of glistening surface the forceps should never be used. Their employment ought strictly to be limited to objects which present some projection that can be grasped, and so traction applied, or to a more or less soft substance, a portion of which the forceps seize, indent, and hold so firmly that, as they are withdrawn, the whole or a portion of the object comes out. Pieces of wood can at once be satisfactorily seized by forceps; also, what is so common in practice, a pad of cotton that has been used as an artificial membrane (so called) in perforations, and which has inadvertently been left in position while other pieces have for some time been placed over it under the impression that it had been removed. Years ago, when Toynbee's artificial membrane was employed, I was very frequently called upon to extract the disk of india rubber which had come off the wire, and found occasionally that syringing failed to remove it; I then used small rectangular forceps; the disk was usually fixed into the tympanic cavity.

The next conditions in which it may be necessary to remove a foreign body from the ear are those which may be spoken of as regrettable incidents,—that is, where the uninitiated, having failed with the syringe, has by the aid of forceps ruptured the membrane. Proceedings of this kind are soon followed by acute inflammation of the middle and external ear, and, after the bleeding has ceased, by a profuse purulent discharge from the ear, accompanied by so much swelling of the canal that nothing can be seen, and the condition of affairs, including the presence of the foreign body, becomes merely conjectural. Frequent syringing with warm water and hot fomentations must be employed, and a considerable time be allowed to elapse before even an examination can be made. No attempt at extraction must be made until every particle of swelling has subsided and the speculum can be used without causing pain. It will then probably be found that careful and daily syringing will suffice to remove the object, and, if this is not the

case, the same rules will guide the use of instruments as in the instances referred to when the membrane was intact. For a child in this condition it will be necessary, if the hook or any other instrument is employed, to give an anæsthetic, for the previous manipulation will have made the patient quite unequal to sitting still.¹

If, after patient syringing day by day and after complete subsidence of swelling, it is found (when the child is under an anæsthetic) that the foreign body for one of many possible reasons cannot be removed, the question arises naturally, what is the next step to take.

This will probably be a case in which the object is of such a size as to have been pushed through the narrowed part in the previous attempt by using a certain amount of force. In such a close fit, so to speak, it may be a very easy matter to push through towards the tympanum, but it will be found not such an easy matter to draw out towards the orifice of the ear. I have more than once been met with this difficulty, and it is not an agreeable confession to have to make that you have failed in what you had expected to achieve. The position, however, must be faced, and I venture to suggest that the wisest course to pursue is the following. So long as the foreign body is movable under manipulation with the hook, notwithstanding the fact that there is purulent discharge and that the object is in close contact with the already ruptured membrane, it may fairly be argued that, if the patient is not suffering pain and the object is not causing irritation or placing life in jeopardy, no further attempt should be made to extract it, and it should be let alone, the ear being simply syringed daily to keep it cleansed from the discharge. I am led to advise this course, which may at first sight appear one of feebleness, but which I believe to be rather a course of masterly inactivity, because experience on several occasions has taught me that when this plan has been followed, after the expiration of many months the foreign body has (although at the time it appeared incapable of passing through the narrow part), aided by a state of complete quiescence and by the daily syringing, appeared at the external orifice of the ear and so been got rid of.

There now only remains to consider what should be done in a case where upon examination under an anæsthetic the foreign body appears to be tightly wedged in the cavity of the tympanum. Even under these

¹ It is a distinct pleasure to be able to say that this state of things is at the present day much less prevalent than was the case some years ago, before the knowledge of aural matters had permeated the great bulk of the medical profession, and, happily, every year that passes by makes these regrettable incidents less frequent. The period is not very distant, let us hope, when they will be relegated to oblivion. In the mean time it is still necessary to exercise a deterrent influence by referring to them. Before leaving this part of the subject I cannot but say that I think it would be a wise regulation to make at general hospitals, that all cases of foreign bodies in the ear should be at once referred to the aural surgeon by the house surgeon, without any sort of interference on the part of the latter. How far this precaution is observed I am not in a position to say, but of the necessity of such a universal rule I am convinced.

circumstances, so long as there is no pain it is well to permit some time to elapse, when the object will almost certainly become loose and movable, thus admitting the rules just laid down to be followed; but circumstances may arise, and indeed in the experience of others than myself have arisen, when the presence in the tympanum of some foreign body causes intense and incessant pain, and, further, when symptoms of cerebral irritation are plainly due to this cause.

Detachment of the Auricle.—Then the question presents itself as to the propriety of detaching the auricle from behind, and thus, by diminishing the distance between the operator and the object, making its removal less difficult. The idea of thus facilitating matters is of very ancient conception, and was mentioned by Hippocrates, subsequently by Paul of Ægina, by Du Verney, and as recently as 1862 Tröltzsch referred to it as a possible necessity. In 1874 the urgency of this operation presented itself to Dr. St. John Roosa in the person of a gentleman who several years previously had accidentally shot himself, blowing away the auricle, fracturing the zygoma, lower jaw, and orbit. Eventually, after twenty-two shot were removed, the external auditory canal partly closed, leaving a constant discharge, and pieces of dead bone occasionally came away. An attempt was made to keep the canal open by the use of leaden probes, and it was thought that one of them was lost in the ear. The patient had for a long time suffered from frequently recurring severe pains in the head, so that he was quite incapacitated from work of any sort. Dr. Roosa separated the auricle, and succeeded in removing a shot from the cavity of the tympanum, but failed (probably owing to the obliteration of the canal) to find the leaden style.

Two points call for attention in this very interesting and remarkable case. The first is that after removal of the shot the severe pains ceased. Hence the operation was amply justified. The second is that five years later the leaden style came away of itself, the ear having been habitually syringed. The lesson to be learned from this instructive case is, I apprehend, that when a foreign body by its presence is obviously causing irritation it is our duty to take all reasonable measures to remove it (as in the instance of the shot), but that when no inconvenience is produced by its presence (as in the instance of the leaden style) we may trust to a natural process for its removal, if the ordinary methods for its extraction have proved futile. The case may be found in Dr. Roosa's treatise, and he refers to the fact that Schwartz had somewhere about the same time detached the auricle for the purpose of removing a foreign body from the ear.

A somewhat similar case occurred in the practice of Dr. J. Orne Green, in which the patient had shot himself after placing the muzzle of a revolver in the auditory meatus. Strange to say, he was alive and conscious three days afterwards, complaining only of headache. Dr. Green detached the auricle and removed from the ear several pieces of lead, weighing forty-

eight grains ; some of the lead, however, had entered the brain through the roof of the tympanum, and the patient died six days after the operation.

This case calls to my mind an incident of a similar kind, the strange sequel of which I have never been able to explain. Some years ago an English officer who was stationed in India attempted to commit suicide by shooting himself. He placed the muzzle of a revolver to his right ear and pulled the trigger. He was found lying on the ground in a state of coma, with complete facial palsy of the right side, and a large wound apparently in a line with the external auditory meatus and bleeding profusely. After being put to bed, search was made for the bullet, and again on several subsequent occasions, but without success. Ten days afterwards he became conscious, and made a complete recovery. Some months later he came to me. The external canal was obliterated, and pieces of bone had come away on several occasions. The facial palsy was complete, as also the loss of hearing on that side, otherwise he was quite well and suffered no further inconvenience. That the bullet had immediately destroyed the aqueduct of Fallopius in the tympanic cavity was obvious from the immediate paralysis. What direction the bullet took and where it was (as there was no opening for its exit) will never be known unless a post-mortem examination is made, and possibly will not be known even then. Indeed, if I had not seen the man and received from the surgeon who sent him to me an account of the accident, I should have regarded the whole affair as fabulous.

Dr. Buck successfully removed from the ear of a little boy a locust bean, "the surface essentially as hard as ivory," which in previous attempts at removal had been jammed through the membrane into the tympanum. Dr. Buck was obliged to detach the auricle in order to do this.

In short, it may be truthfully affirmed that, except perhaps in the remarkable case of Dr. Roosa's, these previous attempts gave birth to the operation, for without them it would not have been necessary to resort to this proceeding. Under certain conditions, however, it is perfectly clear that the auricle must be detached. Fortunately, it is not a difficult matter, and it can readily be readjusted to its place and secured with sutures without leaving any deformity.

Whatever may be said about foreign bodies in the ear, and however careful may be the directions laid down as to their removal, there will occasionally be exceptional examples which defy all anticipation. Among these I shall relate a case which was reported at the Clinical Society on October 9, 1874.

In April of that year one of our well-known sculptors was engaged to execute a marble bust of the gentleman who is the subject of this case. As the cast of the head was being taken, some of the plaster of Paris, in a semi-fluid state, found its way into the external meatus of the right ear, and, coming in contact with the tympanic membrane, became rapidly hardened into a mass, which took a cast of the external auditory meatus for part of its extent in this situation. I saw the patient on April 28, in

consultation with Mr. Booth, of Manchester. The tympanic membrane was entirely covered with the concrete, which was in close approximation to the sides of the meatus for an extent of about half an inch, measured from the farthest boundary of this passage. The deafness was complete, and there was constant tinnitus. No forceps or other instruments could be applied to grasp the mass, as there was no rugged edge to seize; and, besides this, it was firmly moulded to the sides of the passage. As it became necessary to soften the plaster before anything could be done, the questions arose, what were the best solvents of plaster of Paris? which of these were least harmful to the surrounding tissues? and how could they be least harmfully applied? The stony hardness and insoluble character of set plaster of Paris are familiar to every one. It consists, as we know, in chief part of sulphate of lime, with a small proportion of silicate of lime. The only acids which act at all upon it are sulphuric and hydrochloric.

The following plan of proceeding was adopted. While light was thrown through the speculum from a reflector worn on the forehead, I applied, drop by drop, to the centre of the mass, strong hydrochloric acid on the end of a pointed piece of wood, care, of course, being taken not to allow any of the acid to touch the meatus. Several drops of the acid were in this way used at each sitting. This was repeated four days in succession. On the fifth day the mass was so far softened that I was enabled to drill a small hole in the centre by slowly rotating a cataract-needle. More acid was now applied, and by the help of a little hook used by dentists in taking out the stopping of teeth, I could pick away small portions of the now partially softened plaster. In this manner, without giving any pain whatever, I got away enough to gain a view of part of the membrane, and found that the hearing was, although imperfect, not very seriously impaired.

During the days which had been occupied in the way I have described, experiments were being made for me by Mr. Brownen, a practical chemist, upon pieces of set plaster of Paris, and he now brought me some which had been subjected for ten hours to the action of a saturated watery solution of acetate of lead. The effect of this salt had been to reduce a small piece of the hardened plaster which had been soaked in it to the consistence of mud, and this, after exposure to the air for a short time, had taken a crystalline form, and again hardened. The acetate had acted upon the set plaster by decomposing it, acetate of lime and sulphate of lead being the result of the decomposition. The acetate of lime, being a very deliquescent salt, by attracting the water had caused softening of the plaster. The meatus was now filled with this solution, and what remained of the plaster was, in this way, softened so far that I was able to extract it piecemeal, and, the tympanic membrane being in its whole extent exposed to view, the hearing was found to be perfect, and the tinnitus was quite gone. Throughout the proceedings, which occupied eight sittings, reflected daylight was the light employed.

In contrast to this case, it is most remarkable how occasionally the most minute substance in the ear will cause inconvenience if by any chance it should lie in contact with the tympanic membrane. On one occasion an eminent tenor vocalist told me that he was sure a minute piece of horse-hair, from a flesh-brush which he was in the habit of using, had got washed into his ear and was touching his tympanum. He at once became conscious of this when he began to sing, and it disturbed him to such an extent that he did not know when he was in tune. After careful inspection I found he was quite correct, and after I removed it by the syringe the unpleasant sensation was gone.

Irritating fluids which are sometimes foolishly poured into the ear or put on cotton and then inserted into the ear for the relief of toothache or neuralgia should perhaps come under the head of foreign bodies. Among them the chief are laudanum, eau de Cologne, and chloroform. The latter sometimes causes considerable inflammation of the canal, or of the membrane if it gets so far, so that it at once takes the form of a dangerous and active foreign body. The same may be said of the various ear-drops which are sold at chemists' shops, and which are by no means as harmless as generally supposed. They are put into the ear quite irrespectively of what the state of the ear may be, and produce sometimes acute pain and inflammation, especially in those cases where the membrane happens to be the seat of a perforation.

I have also observed considerable irritation to be excited by the constant use of the binaural stethoscope. Quite recently a medical man consulted me for an accident produced by this form of stethoscope. The ivory protection had come off in his pocket, and on applying the instrument to his ear the metal portion had (impelled by the spring) forcibly entered the meatus, wounded the canal, and ruptured the membrane. It is very rare, however, to find a wound in the external auditory canal, and when it does occur it is not serious in itself, but rather forms a detail in the graver injury to the membrane. This, for example, is the case when a person suddenly turns round and some object near is forcibly driven into the ear.

NERVOUS PHENOMENA.

So far it has been made tolerably clear when to proceed in and when to desist from removing a foreign body, and it may be repeated that where the presence of the foreign body is clearly an exciting cause of symptoms, it must be removed. Persistent pain has been mentioned; but if the literature of this subject is consulted, the reader would be apt to leave its perusal under the impression that pain is only one of many symptoms due to the presence of a foreign body in the ear. It is certain that the subjects of this trouble have at times suffered from epilepsy, facial paralysis, convulsions, hemiplegia, and, finally, have succumbed to meningitis or cerebral abscess. If, however, these records are carefully read and subjected to a rigid analy-

sis, the foreign body will be acquitted of all blame, whilst the true cause in every case will be found in the suppuration of the middle ear, which suppuration has been induced by attempts to remove the unoffending and harmless intruder. In saying this I feel sure that my opinion will be endorsed by all aural surgeons of experience. I fail to find a single case in which a solid body placed in the ear and left there has, of itself alone, excited suppuration.

Ear-Cough.—One indication, however, of irritation caused by a foreign body in the ear and entirely unconnected with any attempt at its removal must be mentioned, and this is what goes by the name of ear-cough. In a great many persons it is well known that the distribution of the auricular branch of the pneumogastric is very superficial, and scarcely a day passes that the introduction of the ear-speculum does not excite a cough in some patient whilst under examination. It might reasonably be supposed that with a foreign body lying unsuspected in the auditory canal such persons might be afflicted with a persistent cough, and this is actually the case; on three occasions patients suffering from intractable cough have consulted me for a temporary deafness in one ear caused by cerumen, and on examining the other ear I found and removed the cause of the cough, which was at once relieved. Once the foreign body was an oat, another time a very small stone, and, lastly, a minute piece of a wooden match. In the case of the stone the patient could not account for its presence, but an incident which had been long forgotten and which had attracted no attention at the time was recalled to mind to account for the presence of the oat and the wood.

The entrance of a foreign body into the ear will at times, even although it has been taken out or has itself come out of the ear, leave the patient with distressingly nervous symptoms. Thus, a young lady into whose ear a small spider had crawled, and who was driven almost frantic by the knowledge of it and by the sensation which it caused, remained for a considerable time in a highly nervous and irritable condition, although the spider was removed by a syringe within a few hours of its entrance into the ear.

Another case of a similar kind, which I have mentioned before, was, in its way, rather curious as well as interesting. "In the spring of 1888 a middle-aged lady, clever, sensible, and not at all imaginative, went to stay in a large country house, and was placed in a bedroom which had not been occupied for twenty-five years. In this room, which was well warmed with fires before she went into it, there was a quantity of antique furniture; the first evening she heard the clicking noise (unmistakable to any one who has heard it once) made by a small insect called the death-watch. There are two varieties, I am told, of these insects, both of which infest old wood and sometimes dried skins,—*Anobium striatum*, the ordinary death-watch, and *Anobium tessellatum*, the large death-watch. These animals were afterwards found in the furniture, and a specimen of each was sent to me. On the second night one of them crawled into her ear and awoke her by its

peculiar noise. She was perfectly aware of what had happened, and was not the least alarmed, and had the ear syringed and freed from it next day. Notwithstanding this, she was at times annoyed with the noise at all hours of the day or night for many months, although at other times she was quite free from it. One day the noise ceased and has never returned. I offer no explanation of this, but narrate the occurrence. It was certainly not an affair of imagination, since others heard it when it was in the ear, and it is a loud and peculiar sound."

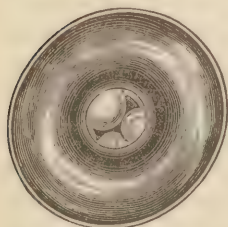
Epilepsy.—It has been stated that the presence of a foreign body in the ear has produced epilepsy, and as bearing on this possibility it is well to examine most closely as to whether the epilepsy is not caused by suppuration in the tympanic cavity, with rupture of the membrane, rather than by the foreign body itself. It has been seen how absolutely harmless in itself a foreign body is when left undisturbed, and how frequently attempts at its removal have ruptured the membrane and set up suppuration in the tympanum. It is easy enough to understand how the suppuration may excite epileptiform convulsions, and, indeed, this is within the experience of many, including myself; but it is not easy to understand how a harmless foreign body in the meatus, not having received an impetus from manipulation which has ruptured the membrane, can induce epilepsy. On referring to a case reported by Dr. Küpper, that of a young woman of eighteen, who was admitted to the hospital with a history of having had severe pain in the right ear, followed by suppuration, we find toothache also set in later, when she put a piece of some kind of root in the suppurating ear to relieve the pain. She was not able to remove it, and since that time she had suffered from epileptiform seizures; they often occurred daily and sometimes several times a day. The auditory canal was sensitive on pressure and full of pus. The canal was filled with polypi. Subsequently the polypi were removed, the piece of wood was extracted, and the fits ceased.¹ It is difficult not to believe on reading this that the part which the foreign body played was that of a cork to prevent the escape of discharge, and no doubt this was the view taken by Dr. Küpper and those who saw and read the report. Thus it cannot be said that this foreign body *per se* induced epilepsy, and I much suspect that a simple foreign body in the ear, left to itself, is quite innocent so far as epilepsy is concerned. Where epilepsy is excited by ear-trouble, it will be found that the cerebral irritation is caused by inflammation in the cavity of the tympanum or by inflammation and caries of the upper wall of the osseous portion of the meatus. What the piece of wood did in the case referred to—viz., prevention of the escape of pus—may be done by a polypus growing from the lining membrane of the tympanum. I have known epileptic fits induced in this way on two occasions. In both instances they ceased when the polypus was taken away.

¹ Dr. Roosa quotes this case in his "Diseases of the Ear."

BONY GROWTHS IN THE EXTERNAL AUDITORY CANAL.

Up to a comparatively recent date the subject of bony growths in the external auditory canal received nothing more than a brief and passing notice. By the old writers they were mentioned as having come under observation, and speculations were raised as to their origin; but they were considered rather as abnormalities which called for notice than as forming a subject which it was necessary to discuss exhaustively both pathologically and surgically. Thus, we find Toynbee speaks of the probability of their origin being gouty, syphilitic, or rheumatic, but further and more recent observation has only served to show that this suggestion was purely hypothetical. The first serious and exhaustive discussion which took place on this subject was on the occasion of the International Medical Congress in London in 1881, when the late Dr. Cassells read a paper upon this matter, and the views of many of the aural surgeons from various countries were elicited. I shall refer to this paper (which contained an historical account of what had previously been written) later on. It will be observed that, although using the term *bony growths* to commence with, it will be necessary afterwards to employ other terms when speaking of them, as they are by no means all of the same character either in formation or in origin. It occasionally happens that on the first examination of an ear the canal will appear to be closed, or nearly so, in its osseous portion by three solid enlargements (Fig. 6), evidently growing from the sides of the canal and approxi-

FIG. 6



Three bony growths (hyperostoses) meeting at their circumferences, seen through the speculum.

imating at its central axis. They will be seen to be covered with skin like the rest of the canal, and be found to be quite hard and solid to the touch of a probe, leaving perhaps a very narrow interspace for the passage of sound. At another time a solitary large, solid tumor will be observed nearer to the orifice of the ear than the foregoing, and apparently arising from the posterior wall of the canal at that point where the bony and the cartilaginous parts join. On prolonged and firm pressure it will be noticed that this solid tumor is perhaps very slightly movable. The first form, which was represented

by three enlargements, is a hyperostosis, the second is an exostosis.

Exostosis.—This latter term used to be applied to all bony tumors, but it is now generally agreed that it must be confined to the solitary tumor which arises by a base more or less broad from the posterior wall of the canal at the point named, the junction of the osseous and cartilaginous parts. The two kinds are as distinct as possible. The exostosis has a history, not so always the hyperostosis. An exostosis is always preceded by inflammation, but it very often happens that the history which the patient gives is not very precise. A time is spoken of, perhaps some years back, when there was a good deal of pain in the outer part of the

ear and behind and under it, followed by a period of discharge lasting a few days and then subsiding; and this is all that I at least in such cases have been able to extract.

However, Dr. Cassells gave a most precise description, and it is worth quoting. He says, "The origin and development of an aural exostosis are as follows: at the outset a sub-periosteal abscess forms over the mastoid, and makes its way out and into the meatus by way of the line of least resistance, ordinarily coming out between the cartilaginous and osseous portions of the canal, sometimes even through the cartilage of the canal, discharging itself and continuing to do so for some time. By and by highly vascular, granular-like growths sprout from the opening of the abscess, and go on increasing in size, while at the same time they are being gradually changed into bony tissue in their interior by the gradual conversion of their cells into bone cells."

I have no doubt that this represents the process accurately, but, as the time at which the patient is seen is generally after the formation has taken place, it does not often happen that we are able to verify by observation each step as described.

Treatment.—When a careful examination has proved the character of the growth to be a true exostosis,—that is, that it grows from the point named, is attached by a base that can be more or less estimated, and is in any degree movable by pressure,—it should be removed: in the first place, because its removal is neither dangerous nor difficult; in the second, because it may by its size at the time or in the future form an obstruction to the passage of sound; or, thirdly, it may in the case of any inflammation of the middle ear become, by preventing the escape of purulent discharge, a very real danger. If the base is not very broad,—in short, if there is a pedicle,—and if in addition to this the growth is fairly movable, whilst the patient is under an anæsthetic a gouge will detach and a pair of rectangular forceps will extract the exostosis without any difficulty; but if the base be broad and the exostosis appears to be firmly fixed, the neatest and simplest way of taking it away is to use a dentist's drill (the forms of which will be figured in speaking of hyperostoses). A few turns of this at the base of the tumor suffice to detach the growth. Whichever method is adopted, it is more convenient that the patient should be, whilst lying on a couch, turned from the light and operated upon with reflected light, the mirror being worn on the forehead of the operator during the proceedings.

Hyperostoses.—It will be noticed that removal of an exostosis is not a difficult matter, and in this respect it is altogether different from the removal of the hyperostoses, which, it may at once be said, are of intense and ivory-like hardness, and so most difficult and tedious to remove, not only on account of their density but also because their position is more deeply situated in the canal. So far as my experience goes, an exostosis is a very rare disease as compared with the other form, the hyperostoses. I use the plural term because hyperostoses are generally multiple, though not

always. More often than not they are found in both ears of the same individual. The most frequent appearance which they present has been mentioned,—viz., three pyramidal eminences meeting at their apices in the central axis of the canal or approximating, according to the age of the growths. As to shape, however, they obey no rule, excepting that their surface is always even. Thus, if they are pyramidal they are evenly pyramidal; if they are rotund they are evenly round and ball-like; if they represent half an oval they have no undulations on their surface: in short, they are always smooth. Sometimes instead of being triple they are double, and sometimes there are four, but then they are generally round, and it is by the approximation of their circumferences that the narrowing of the canal takes place. At another time they are single, and it is not unusual to find one large globular hyperostosis completely or nearly filling up the canal. The patients are usually quite unconscious of the existence of these growths. Their slow and very gradual formation has been painless. It happens very often that the patient seeks advice for some trouble in one ear, and upon examining the other the growths are observed for the first time. On other occasions a slight general deafness is noticed, and both canals are found to be similarly affected; the size, number, shape, and general character of the formations being exactly similar in each ear. This happens especially when there are the three pyramidal growths; at other times the ears are not affected to the same extent in either the number or the size, but it may be accepted as a general rule that if one ear is the seat of these ivory enlargements the other is more often than not similarly affected. Sometimes the patient will discover the condition whilst feeling in the ear with a pencil, match, or similar object, and volunteer the statement that the ear is “closing up;” but generally patients are unconscious of any local obstruction, the fact being that of themselves these growths do not cause deafness. The very smallest conceivable passage for sonorous vibrations to pass to the tympanum is quite enough to permit of good hearing. What happens generally is this: a minute quantity of cerumen having collected, it has been enough to close completely an already nearly closed canal; or whilst taking a bath or bathing in the sea a little water has got into the ear, passed beyond the growth, and, being unable to get out, has made the ear quite deaf; or feeling rather deaf, patients have had the ear syringed, and so become quite deaf. Then for the first time the condition is discovered.

At once, then, let it be said that a person who is the subject of these growths should never have the ears syringed, and that when it is necessary to remove any cerumen which has blocked up the orifice, this must be carefully picked away with the small hook used in the removal of foreign bodies, reflected light, and a speculum (Fig. 1).

Concerning the frequency of these ivory growths, and the various accounts which have been given by surgeons of large experience in different countries, I cannot but think they are far more common in some countries than in others, and, in consideration of the fact that I have taken a very

special interest in the matter, principally perhaps from having met with certain difficulties in dealing with them in 1874, I ask the reader to excuse my dwelling on my own experience more than I should otherwise have deemed right. To show, therefore, the frequency or infrequency, as the case may be, of these growths in this country, I quote from the *Lancet* of January, 1876: "Bony growths in this situation are far more frequent than is generally supposed; and this may readily be imagined when from October, 1874, to October, 1875, no less than fourteen cases came under my observation in private practice, in eight of which only one ear was affected." In subsequent years the proportion of examples in which both ears had been affected has been much greater, so that I have come to consider this as the rule.

An inspection of my case-books has shown that subsequent years have as nearly as possible indicated the same numbers. In order to give an approximate notion of the rarity or frequency of hyperostosis in this country, so as to form a comparison with the experience of aural surgeons in other countries, I give the dates at which persons presented themselves in the routine of private practice between October, 1874, and January, 1876: 1874, October 26, November 11, 16; 1875, February 2, 13, March 11, April 12, 12, 19, May 10, 18, June 2, July 2, August 3, 9, October 19, December 2; 1876, January 19, February 29, March 7, June 22, July 4, July 12, August 1, September 19, and December 4, 14. Whether this, when compared with the practice of aural surgeons in America or on the Continent, is great or small, I have no means of judging; but one point in reference to the frequency of the affection in this country at least is very remarkable, and it is that these hyperostoses are very seldom met with in the poor and ill-nourished,—viz., in hospital patients,—and yet they are equally with the better classes subject to inflammation of all parts of the ear. Another point which will be seen to have a distinct bearing on the causes of the growths is that men are far more subject to them than women. I have taken the trouble to convince myself of the comparative rarity of bony growths among patients in other hospitals besides my own, and find that my experience in this respect is the same as that of other hospital surgeons.

The origin of these ivory-like growths can without any doubt be traced to a local irritation in the large proportion of cases. Thus, they will be found in the canal of a person who has had a perforation, from childhood perhaps, which has discharged for long periods and been free from discharge at other times; the source of irritation has been the discharge passing over the surface which has eventually been the seat of the new growth. The same applies to those cases in which the perforation, having existed for many years, has eventually healed. This course of events I have verified to my own satisfaction in a very large number of cases, and other observers have mentioned this as a cause.

This applies to the instances where the hyperostosis is confined to one

ear, but the same kind of irritation—viz., the constant presence of a fluid in the external canal—may be noticed when both ears are similarly affected in persons who have for many years been addicted to sea-bathing, and especially among those who are expert divers. With these people the ears are constantly getting filled with water. It seems reasonable enough that this unnatural irritation to which the ears are subjected should be harmful in this direction. So constantly had I noticed the connection between diving and hyperostoses of the canal that I drew attention to the fact in 1881.¹

Some patients with this affection will call attention to the fact that for years they have been troubled with itching in the ear, and with a desire to relieve this by scratching the ear with some object at hand, a match or the like. All these facts point in the same direction, but there still remain a considerable number of cases the origin of which is quite unaccountable. I feel pretty confident that they are sometimes inherited, because I have seen them in the ears of a father and his son on several occasions: once I was obliged to remove them in the case of a man, two years later for his brother, and subsequently I saw their father, who had the same affection.

In regard to the rate of growth it is difficult to lay down any rule: certainly it is very slow, and occupies many years; but at the time they are discovered who is to say how long they have been there? One thing, however, is certain, that the growth often stops, and that they remain of the same size for indefinite periods. I can myself speak of cases which are now apparently in exactly the same state they were in fifteen years ago; and this fact has a very distinct bearing on their management and treatment. No one, it is to be hoped, would suggest that these growths should be removed in a case where, although the meatus is reduced to a small aperture, no inconvenience from them is experienced except that every few years a small piece of cerumen closes up this aperture, for this obstruction can be easily removed with a hook.

As has been said already, these cases should never be syringed, for the water will often get behind the growths and cannot be got out, thus making the patient very deaf and perhaps (as I have known it to do) setting up great irritation and even suppuration behind the growths. For the same reason a patient with this affection must be warned not to duck his head into the water in bathing. The subjects of this condition must be made thoroughly acquainted with their state, and warned against the risks they incur if any water is permitted to get into the ears. Indeed, it is to be on the safe side to advise them to have water-tight plugs made for the ears and to use them every morning when they take their bath. I am in the habit of recommending a plug to be constructed which can be made in each individual case to fit the ear accurately. These plugs are made of vulcanite and copied exactly from an impression of wax that is first taken of the ear. The skin over these hyperostoses is exceedingly sensitive, so that very great care and

¹ See Inaugural Address, International Medical Congress.

delicacy must be employed when wax is being taken away from them or from the interval between them. The least scraping of their surface is likely to be followed by a breaking of the skin and the establishment of granulation, with its accompanying discharge, and this condition is not at all easy to allay. Indeed, it is often the state of things brought about by incautious dealing with them that leads to their discovery. For the same reason, nothing could be more disastrous than any ill-advised attempt to excite absorption by local applications of iodine or anything else. It is certain to be followed by inflammation behind the growths, and their immediate removal then becomes necessary, to let out the discharge from so dangerous a position. Another exploit which tends to their detection is the use of ear-drops employed by the advice of some enterprising druggist for the temporary deafness which a little cerumen has caused, for inflammation is at once set up and a surgeon is consulted.

The question now arises, under what circumstances should these growths be removed, and it requires the most careful consideration, the more so perhaps because, whilst up to a tolerably recent date they were never removed, of late years numbers have been subjected to operation for which there was, to say the least, insufficient justification. Let us for a moment suppose a case of multiple growths which, springing from the surface of the meatus by three broad bases, approximate at their apices, so as to render the opening at this position for the passage of sonorous vibrations to the tympanic membrane so small as just to admit the passage of an ordinary silver probe as used in surgery. The patient, let us say, is a man sixty years of age; there is no evidence that the growths are increasing, and none to show how many years they have been present. A small piece of cerumen has closed the opening and made the man deaf; this is carefully picked away, and he hears well. At intervals of a year or perhaps of two or three years he presents himself in the same condition, suffering from a similar temporary deafness, which is relieved as before by the same simple means. The growths bear the same appearance. Certainly no one of sound judgment and large experience would recommend that this patient should submit to a tedious surgical operation, which would for some considerable time (until the swelling had quite subsided) make him inconveniently deaf, when he might be assured that from time to time, as necessity arose, he could be readily made as comfortable as he was on the first occasion.

The same process of reasoning would apply when the growths are smaller. It certainly can never fairly be urged when the growths are small that they should be removed because they are easier to remove when small than when great, on the ground that they are sure to increase; they *may* increase, and most of them undoubtedly do so, but a period always arrives when they cease to grow, and this period often occurs at such a stage of growth that there is ample room for the passage of sound. I have seen this happen not only in numbers of cases of multiple growths, but also in solitary growths, which when they do not fill up the passage of the meatus

give really very little inconvenience. Most certainly this arrest in growth is so common that it should always be present to the mind of the surgeon when he sees for the first time one who is the subject of this condition. Speaking generally, however, it will, according to my experience, more frequently be necessary to operate on single than on multiple growths, for the manner in which they fill up the canal makes them more liable to prove eventually dangerous. Secretion and fluids seem to be more liable to collect behind them and to find more difficulty in escaping than when the growths are multiple.

To sum up, it may be said that when hyperostoses are found in the canal, so long as there is a fairly sufficient opening between them or between one growth and the canal for sonorous vibrations to pass to the tympanum, and of themselves they do not cause distress, provided that there is no discharge, and when on using a Politzer bag there is no passage of air through the membrane,—that is, there is no evidence of a perforation,—they should be let alone, with the usual precautions already mentioned as to the avoidance of water getting into the ear. If, on the other hand, there is found to be a profuse purulent discharge from the ear, coming from a perforate membrane, as shown by the history and perhaps also by the fact that air passes through the perforation when forced through by the patient or by a Politzer bag (it is often the case in perforations that the air cannot be so forced through), the patient may be at once pronounced to be in peril, since the discharge has not a free exit, and the growth must be taken away to provide a free escape for the discharge and so diminish the risk of meningitis, cerebral abscess, or some other trouble arising from septicæmic poisoning. The urgency for this proceeding would be considerably greater if the patient were suffering from head-pains, giddiness, or other symptoms of pressure. This rule will generally be agreed to by most aural surgeons, but, as in other cases of difficulty, a good deal will depend upon the judgment of the surgeon in the particular case under examination. Thus, I have known instances in which the growths have not been very large and there has been a perforation of many years' standing, in which it could not be said off-hand that an immediate operation was necessary; for example, where the perforation for many successive years had maintained a quiescent state without any discharge, but in which at the time there was a slight discharge, amounting perhaps to nothing more than a little moisture, lasting only a few days, and then subsiding into the accustomed quiet and inoffensive state. In such a case, especially if the patient be advanced in years, it becomes a question whether it is not better to let matters alone, warning him or her in the event of any sign of acute inflammation to apply for relief, and then operating at once. Again, there is no reason why a large growth, which so nearly blocks the canal as to be a constant source of annoyance by retention of cerumen, should not be removed in the case of a young man or woman. So that, with these general directions to guide us, we must each of us decide according to the best of his judgment.

Treatment.—Before going into the subject of the methods of removing these ivory-like hyperostoses it will be necessary to refer to two cases; for, as has been mentioned, the removal of this kind of growth is of more or less recent introduction. In January, 1875, a gentleman aged thirty, who had suffered at times for many years from a discharge from his ear and a perforation of the membrane following scarlet fever at four years of age, asked my advice, when his ear presented the following symptoms. The canal was practically closed by a large globular ivory hyperostosis. Thick, purulent, fetid matter was exuding from the ear; the circumference of the growth where it approached the meatus was covered with exuberant granulations. He was suffering from pain confined to that side of the head, a sense of fulness, and occasional giddiness; the temperature was normal. It was obvious that pus was pent up behind the growth and that his condition was full of peril. It therefore became necessary, without more delay than could be helped, to provide a free egress for the discharge, by the removal of the bony growth. The base of the tumor was evidently very broad. With the assistance of Mr. Edglow, the dental surgeon to St. George's Hospital, who provided me with drills and turned the dental engine, whilst the patient was under ether I drilled away the upper three-fourths of the growth and thus provided a means of escape for the discharge. All dangerous symptoms then passed away. In a communication to the *Lancet* in January, 1876, I discussed this plan of proceeding, and said, "I know of no such ready method of destroying these bony growths when their removal becomes imperative." The second case which I must mention occurred in the practice of Dr. Mathewson, of Brooklyn, New York, in 1876, and is fully detailed in the Report of the First International Otological Society, 1877. He also employed the dental engine, drilled away the growth, and placed the patient, who was previously in great danger, in a position of safety.

The inventive genius which seems indigenous to America had long before these two cases made us familiar with the scientific drilling of bone in use among dental surgeons, so that nothing was more natural than that I in the first instance, and Dr. Mathewson in the second, should have instinctively availed ourselves of this excellent plan of dealing with bone (Dr. Mathewson had probably not noticed my paper in the *Lancet* when he first adopted it) when we found ourselves in front of a difficulty that must immediately be met. Since then the drill has been called into request by others in operating upon aural hyperostoses. Before this time, however,—namely, in 1873,—Dr. Thomas E. Clarke successfully removed a large bony growth from the auditory canal in the following manner. Two needles were introduced at the base and one at the anterior edge of the tumor. Then through these needles was passed a current of electricity from six pairs of plates of a Stohrer's battery for three minutes. This was repeated fourteen days afterwards; three weeks later the growth was so loose as to be readily extracted. Although I had adopted this plan and

succeeded in getting away growths, it is altogether too lengthy a process when it is necessary to give relief at once, and since using the drill I have not reverted to it.

To turn again to Dr. Mathewson's case, there were many points which throw considerable light on this subject and so are most useful in dealing with these cases. It is well worth reading by any one who practises aural surgery. The subject of it was a lady about twenty-five years of age in 1873, and at that time—as shown by Dr. Roosa, who examined it—the tumor was solitary and blocked up the external auditory canal. She had suffered from pain at times till eleven years old, but since then had had no pain in the ear, but a sense of fulness in the ear, and pains in the back. There was no discharge and no evidence of a perforation. In all probability she had a perforation in early life which had healed. Thus the case differed in some points from the one under myself, in which the symptoms from the first were urgent. It also varied in regard to its end, for after the operation in 1876, three years after Dr. Roosa saw her, the patient obtained good hearing. Taking this case in conjunction with others which I have met with, it may fairly be argued that in a young person who is the subject of a large solitary hyperostosis it is advisable to remove the tumor.

Having endeavored to make it clear what sort of cases demand operative interference, and as to method having expressed an opinion in favor of drilling, before proceeding to describe the details of this operation as taken from personal experience it must be stated that in cases of single large hyperostoses some surgeons have successfully employed the gouge; but, as far as I can gather, it has been in those instances in which there is a distinct pedicle; when this is the case I can readily understand that the gouge will easily effect the removal, especially if the meatus is of unusually large calibre. It will, of course, be necessary to exercise great caution in directing the gouge. When the patient is lying down, the gouge must not be pointed straight down the meatus, but in such a line that whilst it cuts through the pedicle any further force than is required for this purpose is directed rather towards the bony meatus than towards the tympanum. When the gouge is employed, a sharp blow is given to it with a mallet, for prolonged pressure is not enough to cut through the pedicle, certainly not if the growth is of the ivory-like hardness met with in all the hyperostoses which I have seen. At the best it seems to me a somewhat rude method, and unnecessary when the drill will so easily and without jar cut through a pedicle. At the same time, it is but just to say that I have seen a case in which the gouge and mallet were employed by Mr. Shield, of Charing Cross Hospital, most successfully. The growth was a very large hyperostosis, and previous to removing it he had detached the auricle from behind and turned it forward, in order to give him more ready access to the tumor.

This detachment of the auricle is well worthy of consideration in operations of this kind when it happens that the meatus is unusually small. Per-

sonally I have not been obliged to resort to it, but I can readily understand that it might be not only useful but necessary in some instances ; for unless the meatus is of fairly good size the space in which we have to work is often very small, and this difficulty is increased when the tumor is, or from the formation of the ear appears to be, more deeply placed than usual. I think, then, that any one who has to deal with these cases must be prepared, if the occasion demands it, to detach the auricle as a preliminary step. It is not a difficult matter, and the auricle can be readily replaced in its natural position and attached by sutures. It would distinctly put the growth in a less secluded position, and it would not be necessary to work through a speculum, both of which conditions would be advantages if the meatus were unusually small.

Even if it were necessary to do this, I still think that the drills would be found in every respect much to be preferred to the gouge and mallet ; certainly any one in the habit of operating by drilling will endorse this view. In saying this it is implied that experience gives facility in using the drill upon these extremely hard growths, for until one has had to grind away portions of what is aptly termed ivory I am sure he can have no idea of the extraordinary density of these structures. The difficulty is enhanced considerably if the operator, as was the case with myself, takes into his hand for the first time an instrument or tool in the management of which he has no experience to guide him. Thus, the tendency in the first instance is to use much more pressure with the drill than is necessary, and this is a tendency that should, for obvious reasons, be avoided. The ordinary dental engine, which I first employed, was turned with the foot, and it was necessary that an assistant should do this, turning and ceasing to turn at the word of the operator. With this engine it was necessary to use somewhat more pressure than with the one which I afterwards employed, as the revolutions were not so rapid. Any one who is accustomed to use a lathe for the purpose of turning in ivory or wood will appreciate this at once, but, as many surgeons like myself have not acquired a facility in working with a lathe, it is as well to mention it.

Some years ago, when I was in the habit of using this simple dental engine turned by the foot, my friend Mr. Winterbottom, consulting dental surgeon to St. George's Hospital, introduced to my notice an electric drilling machine, which I have used ever since, and which has been of the greatest possible help in lessening the labor in these operations. It consists of an ordinary Cutriss electro-motor, to the spindle of which is attached a long flexible arm, terminated at its free extremity by a hard piece adjusted to hold any required instrument. The rate of the revolution is controllable by means of a resistance-coil, and can be varied from two hundred to five thousand turns a minute. The question then arose, what rate of speed should be employed in operating on these ivory-hard growths? Together we made experiments with cutting drills and burrs on pieces of bone, teeth, and ivory. At the highest speed bone could be cut through with astounding

rapidity, and the fang of a tooth was cut off with great ease. It was gratifying to find that the slightest possible pressure was required. However, it was soon evident that in operating on a large hyperostosis it was necessary to limit the speed; for with the very hard substance of which the growth was composed, if the highest velocity were used, such great friction was produced that the drills and burrs were heated to so high a temperature that they lost their temper and were blunted. We found that the best speed was twenty-five hundred revolutions per minute, and that at this limit the best cutting could be obtained without blunting the instruments, and at the same time the great advantage of not having to use pressure could be retained.

When it has been decided, for the reasons previously mentioned, that a patient should submit to the removal of a large hyperostosis, he should be placed in the horizontal position, with the head slightly raised by a small pillow under the nape of the neck. As the proceeding occupies some time, it is of the greatest possible convenience to the surgeon to sit in a chair. For this reason, the couch or table should be a little higher than a writing-table; this height allows the surgeon to operate comfortably and without bending down his head, and, as he is working with reflected light and so has a mirror on his forehead, the precise elevation of the patient is very important. If the patient is on an ordinary couch or bed, the operator has to kneel to be on a level with the ear, and this I know from experience is most wearisome. This fatiguing experience induced me afterwards to be particular in arranging the position of the patient. If good daylight is obtainable, this is the best, and the reflector can be placed on the forehead, but if the day is dark (and this in London is very frequent) I use an electric illuminator worn on the forehead in place of the reflector. I am sure that it is better to employ reflected light than direct light in all cases, and unless the growth projects to very near the external orifice it is absolutely necessary, since a better view of its position is obtainable both superficially and deeply. It would not be necessary to discuss this point but for the fact that direct light has been employed in this proceeding.

The patient being in position, there is no occasion to remove any cuticle, and the drilling may be begun at once. As these growths do not during consciousness bear much manipulation, owing to their great superficial tenderness, when the patient is under ether a more correct estimate of their shape can be obtained, a very small probe being used in examining. The anæsthesia must be very complete, as it is most important that the patient should be quite motionless. If the examination shows that there is a pedicle, the proceeding becomes at once tolerably simple, for then the pedicle can be ground through with cutting drills (Fig. 7). It is the best plan to bore a hole through the pedicle and then to enlarge the opening, then to cut from one side first, then from the other, until the cuttings from each side meet at the central hole that has been made. The growth being detached, it can readily be pulled out of the meatus with a hook.

As a rule, however, it will be found that the base is broad. In this case the best plan will be at once to drill an opening into the centre of the growth, then enlarge the opening with fissure-burrs, and keep on increasing the size of the burr as the opening gets larger. In short, grind the tumor away as quickly as may be possible, until there has become established a good passage for discharge to escape and sound to pass.

Sometimes after prolonged grinding it will be found that the growth is much deeper and larger than was expected, and, instead of what first appeared, viz., a large globular mass filling the canal, it will appear hollowed out, with a large cup-shaped cavity in the bone. Then, although the tumor has not been removed, it must not be hastily concluded that the operation is unsuccessful, for "its life has been destroyed, and some weeks later its dead and shrivelled form has become loose in the meatus and it has been removed as a foreign body by a hook, forceps, or syringing." (Fig. 8.) If the operation has been undertaken in a case where it is necessary to provide an immediate outlet for pus, it

must not be allowed to rest here: the drilling must be continued until a sufficient passage has been made. But in stopping at this point, and in the final coming away of the tumor, I was dealing with a large growth which completely blocked up the canal, but in which there was no supuration behind. The figure here shown and the specimen itself give no appreciable idea of the growth, as the tumor in life was very large and quite filled the canal, though it came away as a dead and shrivelled mass of bone exactly six weeks after the operation. It was removed from the ear of a lady of twenty-four; it so tightly filled the canal that she was deaf from its presence, and the hearing was perfect after it came away. There was no history of any previous inflammation or trouble with the ear, and the other ear was

quite healthy,—briefly, a large hyperostosis without a history. It is hardly possible that she was born with it, as till a few months before I saw her she had never been deaf. An almost precisely similar course of events happened in the case of a gentleman who had exactly the same kind of growth in the right ear, which I treated in the same way. Two months afterwards he sent me the shrivelled remnant, which he had, on finding it loose

FIG. 7.



Drills, burrs, and trephine for removing bony growths.

FIG. 8.



Dead, shrivelled mass of bone, the remains of large hyperostosis which came away six weeks after it had been hollowed out by drilling. The hollowed cavity can be seen at the left of the figure.

at the orifice of the ear, picked out. In his case also there was no history of any sort, but the other ear was affected with multiple growths, which, however, were not large enough to make their removal necessary. I have seen him occasionally at intervals of about a year, and the growths are no larger.

I have given in some detail the *modus operandi*, but the best way of drilling will be suggested to the operator by the size and position of the growth as it appears to him. In selecting the drills he will also be guided a good deal by the size of the meatus. It may be said at once, the more capacious the canal the easier will be the business. A silver speculum of the largest size that can be employed must be used, and the straight piece must be as short as possible, for it is desirable to get as near the object as practicable and to have plenty of space for the drills. It will be noticed that the drills are of considerable length; they were made long in the shank because it is desirable to keep the hand at a considerable distance from the speculum. Unless this be done, the view will be obstructed.

I mention in detail all the difficulties which were noticed (trifling, perhaps, but none the less embarrassing), as it is useful to note them and how they were overcome. Thus, in the earlier cases, when the machine was turned with the foot, the constant oozing of blood was most troublesome. Every few moments it was necessary to stop and clear away the blood with absorbent cotton, for it was impossible to see exactly what portion was being acted on or what progress was being made; this drying lengthened the process very much, as the oozing was constant. In some of the cases the patients were as long as fifty minutes under ether, and, as no movement could be permitted, the anaesthesia was profound. The increased velocity, it was found, had a twofold value. In the first place, the destructive action of the drill was far more rapid, and, what was of even more importance, the oozing of the blood gave little or no trouble. The great heat produced by the friction, by coagulating the albumen, checked the hemorrhage. As a matter of fact, what in the earlier cases took fifty minutes could be easily accomplished in something like twenty minutes.

It is of great importance in using the drills that at the first moment they touch the growth they should be held perfectly steady, as is done in turning with a chisel. There is a natural tendency towards a wobbling motion, which must be guarded against, for there is not, as in turning, a rail which steadies the instrument and hand: so great care must be used not to have the notches of the drills or burrs too deep. If they are deep it will be impossible to prevent the wobbling movement, and the drill by slipping against the surface of the meatus will lacerate it and produce most inconvenient oozing of blood.

The question will naturally suggest itself as to the risk of the drill's slipping forward, and in the case of any one using a drill turned with such velocity, and seeing how rapidly it cuts through all obstacles, this danger will be at once and constantly present to his mind. Considering what

would happen if the drill did slip forward, this idea is not surprising. It is therefore of the utmost necessity that this question should be cleared up. This slipping forward cannot take place unless considerable pressure is exercised upon the growth. No pressure of this kind is needed to use the drill effectually. When the drill has worked clean through the growth the pressure behind it ought not to be enough to induce any further forward movement of the drill. Unless the one who proposes to operate on these growths can fully grasp this idea and act upon it, he had better not make the attempt. Any notion as to a guard behind the growth to avoid this danger presupposes the employment of an amount of pressure which is not only unnecessary, but even dangerous. In cases where it is necessary to operate, the growth is so large that between its circumference and the external canal it is almost impossible to pass the smallest probe, and it would be quite impracticable to pass any sort of curved guard. If I dwell so much on the mechanical aspect of this operation, it is perhaps because I have at the moment before my mind the difficulties I personally experienced, and I do not forget that if it were not for the American invention which has made these operations possible I should not be dealing with the subject.

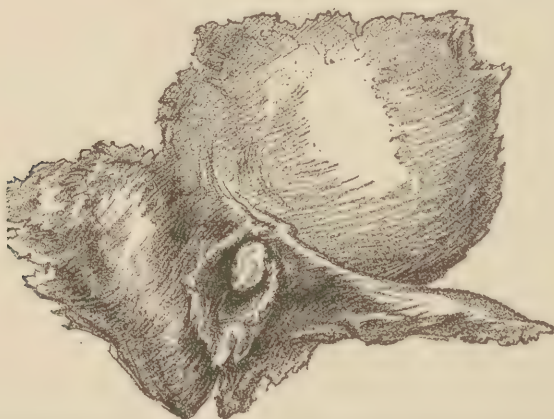
Before the removal of a hyperostosis is undertaken, the patient should be warned not to expect relief of deafness immediately, nor until the swelling which follows the operation has subsided. As soon as the patient recovers consciousness there will sometimes be pain, which must be relieved by hot fomentations. For some weeks afterwards the meatus will be crowded with bone granulations, which will, however, disappear after the healing process is concluded. If this state of things is prolonged, their disappearance may be hastened by the application daily of some finely-powdered gallic acid blown into the ear with a tube after the canal has been cleansed with a syringe and then carefully dried with absorbent cotton.

There is something eminently satisfactory in the termination of these cases, and I think it must be admitted that they contrast favorably with the records of similar ones in the literature which precedes 1875. In truth, for these I can find no termination, unless it is in those examples where the subjects of large hyperostoses accompanied with perforations were shown by a post-mortem examination to have died of cerebral abscess or meningitis, due apparently to the blocking up of discharge. In a well-known case of this kind the brain and temporal bones were exhibited at the New York Pathological Society in 1867 by Dr. Agnew, of New York. The case was instructive in many ways. The patient had been known to have bony growths for several years, and an attempt had been made in London to dilate the canal with bougies, the only effect of which was to cause great pain (we know now how futile and harmful this is). He died about two years after, of inflammation of the membranes of the brain, induced by suppuration of the cavity of the tympanum, the pus not being able to find an outlet on account of the presence of exostoses (Roosa). From the history,

there was no doubt that this patient had in early life been subject to inflammation of this ear, so that the bony growths, two in number, were due to periosteal inflammation. In 1864 they occupied three-fifths of the calibre of the meatus, and in 1865 nearly closed the canal, so that the growth was at one time somewhat rapid.

To go back for a moment to Dr. Cassell's cases, it will be noticed that they were true exostoses. One was incomplete so far as bony structure was concerned ; it had the appearance of a polypus, but the pedicle was of bone growing from the outer half of the posterior wall of the canal. In all probability the whole tumor would in time have become bony, so that it showed an exostosis in process of formation. In the other case a fibro-vascular tumor projected from the meatus for about half an inch, and after this was removed an exostosis was found behind it. This had a very distinct pedicle, and before removing it with a gouge and mallet Dr. Cassells twisted a loop of wire round the pedicle so as to grasp it. This wire ligature enabled him easily to draw the tumor out of the meatus after it had been separated from its attachment. It will readily be seen that when there is a pedicle which will admit of a wire being passed round it this will facilitate the extraction of the tumor after it has been detached, and will prevent it from sinking deeply into the meatus as it is loosened ; but in the case of a hyperostosis this will never be found practicable, for the base of the tumor is generally too broad, or there is not sufficient space to pass a wire round it. In short, it will be seen from what has already been said that the removal of bony growths in the auditory canal is, strictly speaking, a *removal* rather than an *extraction*, since it often consists in a grinding away or destruction.

FIG. 9.



Right temporal bone from a man, found in a skull repository in Hallstadt, Austria.

The subjects of hyperostosis are equally with other persons liable to affections of the middle or internal ear, so that in a case where an operation is under consideration for the relief of deafness alone (for example, when the tumor absolutely blocks up the canal) a most careful examination

with the tuning-fork on the cranial bones is necessary, as well as a very exhaustive history of the case, lest it be found that the tumor has been removed without any amelioration of the hearing-power. Many subjects of hyperostosis are very liable to catarrh of the middle ear, and the very existence of a bony growth in the meatus should make the observer peculiarly suspicious of a previous inflammation of the tympanum.

Before concluding a surgical account of bony growths, it should be mentioned that historically they present points of interest, inasmuch as there seems to be no doubt that some nations have been found to be extremely liable to exostosis, as shown by those who have examined large numbers of human skulls, notably those of the aborigines of America. This fact has been pointed out by Seligmann, Clarence Blake, and others. Professor Politzer has kindly sent to me a drawing (Fig. 9) of a temporal bone in the museum at Vienna which shows an exostosis at the upper portion of the meatus.

NEOPLASTIC NARROWING AND CLOSURE OF THE EXTERNAL AUDITORY MEATUS.

Closure of the external auditory meatus is by no means so rare a condition as might be expected from the formation of this tube and its ample orifice. Thus, although not a disease but rather an abnormality, the opening to the external ear is found to be closed in most of the congenital malformations of the ear. It is, however, noticeable in these cases that, although the closure is apparently complete, a more searching examination will discover a minute opening, which will just admit a fine probe, and from this opening it will be found that there exudes a certain amount of moisture. In short, it is a fistula; and there seems little doubt that the suggestion which was made by Sir James Paget in a paper read at the Medico-Chirurgical Society in 1877, "On Cases of Branchial Fistulæ in the External Ears," is the true explanation of these conditions,—viz., that they are branchial fistulæ, and are due to incomplete closure of the upper or post-oral fissure, or rather of that part of it which is not utilized in the formation of the Eustachian tube, tympanum, and meatus. A very good specimen of this may be seen in the museum of the Royal College of Surgeons in a rudimentary ear which in 1875 I removed because of its unsightly appearance.

Treatment.—I mention this form of closure in cases of malformation because it has a distinct bearing on some pathological forms of closure which are the result of inflammation, and in this way. In almost all instances of congenital malformation there is absolutely no hearing, so that any attempts to make a permanent opening are out of the question, but there are instances, and I have seen more than one, in which it would appear that the chief part at least of the malformation is confined to the external ear, inasmuch as the children have possessed enough hearing-power to acquire speech. Now, in such cases, so long as the obstacle to sound was confined to skin and tissue over the external orifice, it would be right to use all available

means to make a permanent opening. Attempts in this direction have been made, but so far as I am able to ascertain they have always ended in failure, and the difficulties met with in keeping patent the openings made are so similar to those encountered in the case of pathological closure that they are worth mentioning in connection with this subject. The similarity does not end here, for the pathological closures are not complete, any more than the congenital. When the external canal is the seat of acute inflammation attended by a profuse purulent discharge, as the latter subsides, in a certain number of cases, firm cicatricial tissue forms at the orifice and closes the canal, with the exception of a minute opening similar to that which is found in the congenital closures, and through this also oozes a little discharge. At other times this circular band of tissue is found a short distance, about a quarter of an inch generally, in the canal, and, unless the observer has met with it before, it presents a very puzzling object with a minute hole in the centre. Its surface is red, flesh-colored, and glistening. That it is not very dense in structure will be shown by the fact that it is elastic when pressed on by a probe. How difficult it is to get rid of, those only know who have struggled with this barrier, for its activity in reproduction is marvellous. Whether it is situated in the canal or is quite external, to remove it with a knife or with any sort of caustic and then let it alone is simply to invite its rapid reappearance in a few days. If the ordinary methods of keeping an opening patent are attempted, disappointment succeeds disappointment. Pieces of gum-elastic catheter, pledgets of lint, sponge tents, and the like, fail to preserve the opening, for no sooner are they left out than new growth begins.

As an example of the difficulties in treating these cases, I am induced to quote, as a personal experience, a case reported in the *Lancet* in January, 1876, for it serves to illustrate the difficulties mentioned better than any recapitulation of them would, and it also shows how these difficulties may be overcome.

"In February, 1875, a young lady aged twenty-nine applied to me under the following circumstances. In the middle of the previous October she, being in good health, was seized with acute pain in both ears. This lasted five or six days, and was succeeded by a purulent discharge from both ears and cessation of the pain. After this the suppuration continued to be profuse, and there was occasionally some return of the pain, for the relief of which poultices were very frequently employed. It was during this period that the external openings of the ears, being subjected, as they were, to the irritating influence of the discharge, became inflamed, covered with granulations, and, lastly, were the seat of cicatricial tissue; in other words, the tragus on each side having been lost by ulceration, the openings of both ears skinned over, leaving, however, a minute hole (large enough to admit an eye-probe), through which, from time to time, oozed a thin purulent discharge. The deafness on both sides was extreme. From the history of the case it would be supposed (although this supposition eventually turned

out to be incorrect) that the tympanic membranes were perforated. Both sides were treated in the same way. The patient was placed under the influence of ether. Taking the small orifice above mentioned as a centre, a free incision was made upward, downward, inward, and outward, and the opening thus made plugged with lint. On the next day the lint was taken away and replaced by pure lead arranged as follows: a piece of thin sheet-lead was rolled until it was the size that exactly fitted the canal, and was then inserted to the depth of about three-quarters of an inch. The plugs were removed night and morning, the ears were syringed, and the plugs replaced and kept in position by a bandage round the head. In the course of ten days the rim of the openings had cicatrized around the lead; the canals were of their natural calibre, and an examination of the tympanic membranes became possible. It was then found that they were entire. There was no further discharge from the ears. The difficulty in the management of the case now began, for it was found that if the lead was allowed to remain out of the ears for even half an hour, the meatus became swollen and painful, and there was the greatest difficulty in replacing the lead. This curious condition was so marked that the patient one night took out the lead at ten o'clock, syringed the ears, and by my desire left out the lead till eleven o'clock. She then found that she was unable to replace it, and came at twelve o'clock to me, when I was obliged to use considerable force, causing great pain, before I could reinsert the lead. For more than two months the patient used the greatest care in managing the replacement of the lead after it was taken out of the ears, very gradually increasing the periods during which she left the ears without the plugs from ten minutes to twenty, and so on up to four or five hours. At the end of two months the openings were considered to be permanent, and the ears were left unmolested. Four weeks after this, having left London, she awoke one morning feeling great heat and pain in the left ear. She attempted to put in the lead and failed. Ten days later she came up to town again with that ear in precisely the same condition as before the operation, the right ear, however, continuing well. To make a long story short, so far as the left ear was concerned all the same trouble as before was gone through. She made a good recovery, and both meatuses have since remained normally patent."

I am informed that quite recently Dr. C. H. Burnett has succeeded in removing what he aptly describes as "a neoplastic bridge-like band" which lay across the canal without completely closing it. In another case which ten years ago I treated on the same plan as that described in the *Lancet*, so alive to the possibility of closure is the gentleman who was the subject of operation, that to this day, although there is no occasion for doing so, he persists in wearing a small leaden tube (which he makes for himself) in the canal. Another patient does this, not only by his wish but also by mine, for the conditions with him are different. He has a small perforation, which, however, interferes very little with his hearing, and from which there is a discharge, so slight as to give him no inconvenience. Still, so

long as there is this source of irritation, which, so far as I could judge, induced the closure in the first instance, it is better that he should wear the tube. This, at any rate, he does, washing it and replacing it only every two or three weeks.

Another form in which a distinct *stricture* of the meatus occurs is that met with in cases where large portions of the osseous canal have become carious, the sequestra have come away, and contraction has taken place to such an extent that the orifice will hardly admit a small probe. It is noticeable, however, that in these cases, which usually follow scarlet fever, caries has been part of the general inflammation. This has involved the tympanic cavity and the membrane, and there is no hearing left. Nothing would be gained even if the meatus could be re-established. It might be supposed that in a condition of this kind some attempt ought to be made to form an outlet for discharge for reasons of safety to life,—that is, to avoid the risk of brain-inflammation; but as a matter of fact, in practice it is found that by the time these strictures have formed the middle ear has become quiescent. Of course exceptions may be found, and indeed have been recorded, when inflammation of the brain has taken place, apparently owing to the inability of the discharge from the tympanic cavity to escape; but I am stating now what is the general course of events.

Of all forms of narrowed meatus none are so common as those which are the result of prolonged eczema. In an extreme case of this kind the meatus is so narrowed that it is represented by a passage that will just admit the smallest probe made. The subjects of this affection are old gouty persons who have for so many years had a chronic eczema that they pay very little attention to it. Indeed, it is owing to their negligence that they have arrived at the condition under notice. A slightly irritable state of the canal is the beginning of the trouble, and the moisture of eczema and incrustation of the discharge in the morning are observed, but these people are generally as careless of this as they are of their diet. As years go on, so does the inevitable infiltration of the tissues which makes the canal less and less. By and by the time arrives when they will say that their ears are closing up. The cause of this indifference is to be found in the fact that during all this time the hearing has generally remained good, and, strange as it may appear, by the time the deafness has attracted attention the canal is often found to be so small that it is impossible to clear it with a syringe. Even then, however, a good deal may be done by careful management. A simple ointment of ammonio-chloride of mercury inserted on the end of a probe tipped with absorbent cotton relieves the irritation and somewhat reduces the swelling. If added to this the patients submit to rules of diet of an anti-gouty character they hear far better than could be supposed possible according to all appearances. Cases of this kind show how very slight a passage for sound is sufficient for purposes of hearing. In this condition any

attempts at forcible dilatation only aggravate the trouble, as they at once excite inflammation which completely closes whatever little passage there may be. In very old persons the anterior and posterior portions of the cartilaginous part of the canal very often approximate, so that at last there is a perfect collapse, so to speak, and the external opening is confined to a very narrow slit. Thus, if it is necessary to syringe the ear, this becomes a very tedious process, and, even apart from this, the aperture is so slight as of itself to impair the hearing. In such examples a small silver tube may be habitually worn with great advantage, and, as the shrinking is not the result of inflammation, the presence of the tube does not excite irritation. This is probably the only condition in which a silver tube can be worn with comfort and without exciting irritation, for apart from bony enlargement a narrowing of the canal always starts from some inflammatory process. It would almost seem that in some persons, even when there is not a disposition (so far as can be judged) to gout, the bony part of the canal has a tendency to enlarge generally as age advances, and so narrow the channel, since this diminution of its calibre is seldom met with in the young. This state is usually associated with undue secretion of cerumen, and so gives a good deal of inconvenience, entailing, as it does, a frequent and tedious syringing. The general enlargement of the bony portion of the canal is in no way connected with the bony growths which will be described under the head of exostoses and hyperostoses, and it is simply mentioned as having frequently come under the writer's observation. No explanation of its cause is given, since no satisfactory one can be suggested beyond the fact that it would seem to be one of the accompaniments of advanced life in like manner as is the collapse of the cartilaginous part of the meatus.

When there is a complete occlusion of the external meatus such as has been previously mentioned, it is a matter of speculation what is the condition of the deeper parts. I have, however, received from Prof. Politzer an account of two post-mortem examinations which he had the opportunity of making. One was in the case of an old woman who had been under Dr. Politzer's observation for twenty years before her death. Originally on the left side there had been perforation and polypoid growths, which later on filled up the entire meatus. Suppuration then ceased, and the polypoid granulations formed adhesions to the wall of the canal, so that there resulted a total obstruction of the meatus, the external opening of the ear presenting the appearance of a depression or dimple, the rest being epidermis. There were complete deafness and facial palsy. The autopsy exhibited the following results. The meatus was completely filled with connective tissue which not only extended to the tympanic cavity but also filled this in the upper part; the lower part of this cavity was occupied by a cretaceous mass, the pyramid having partly suffered destruction. There was no trace of the ossicles or tympanic membrane. The inflammatory proliferation of tissue extended to the inner ear, involving the lower part of the bony wall

of the vestibule, the internal meatus, and the cochlea. There were also discovered several irregular tumors connected apparently with each other, proliferating from the inner meatus and compressing the transverse sinus; these tumors consisted of dense and hard fibrous tissue exhibiting, in their interior, cavities filled with detritus; the mastoid process was sclerotic.

In the second case the external meatus of each ear was affected. A discharge had existed for many years, and the bony meatus seemed to be closed by a firm mass of tissue having the appearance of a funnel-shaped cavity. The hearing, however, was relatively good. At the autopsy this mass of tissue was found to be covered with epidermis; beyond this it was found to be grown on to the tympanic membrane at its anterior and inferior part, the posterior and superior part being free. The membrane was drawn in so much that it appeared funnel-shaped and was adherent to the back wall of the cavity.

PLATE I.

DESCRIPTION OF COLORED DRAWINGS.

Figure A. Normal membrana tympani.

Figure B. Injury from a sharp-pointed instrument to the drum-membrane in its antero-inferior quadrant, and congestion about Shrapnell's membrane and along the handle of the malleus.

Figure C. Injury to the membrana tympani from a blow, showing an oval rupture and the reddish-yellow wall of the tympanum in the case of an otherwise normal drum-head.

Figure D. Moderately severe inflammation of the membrana tympani, with retraction of the latter and displacement of the cone of light in a case of acute catarrhal otitis media.

Figure E. Appearances seen in a case of so-called "otitis media serosa" or hydrops ex vacuo (Zaufal). The drum-head is retracted and the short process prominent, the upper half, containing air, of a grayish color, while the lower half, which is filled with serous exudation, is of a greenish-yellow color.

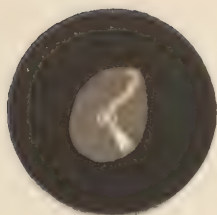
Figure F. Bluish-red appearance of the membrana tympani, with a minute perforation in the postero-inferior quadrant of the same, as frequently seen in cases of acute purulent otitis media; also bulging of the membrane around the short process.

Figure G. Hyperæmic appearance of the membrana tympani, as shown by a net-work of blood-vessels, with a grayish-red color of the drum-head. Marked congestion about Shrapnell's membrane and extending along the handle of the malleus. The short process stands out as a yellowish-white tubercle.

This appearance of the membrana tympani is frequently observed in cases of acute catarrhal and acute purulent otitis media where the membrane has been deeply congested and all landmarks have been lost and inflammation of the same is gradually subsiding. The hyperæmia gradually fades away in the lower half of the membrane at first, and finally disappears from the short process and the handle of the malleus.

The same appearances are also seen in cases of acute myringitis.

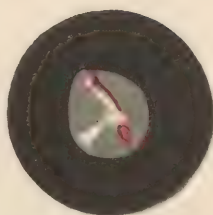
PLATE I.



A.



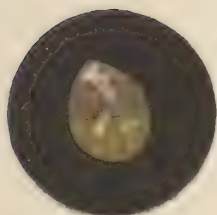
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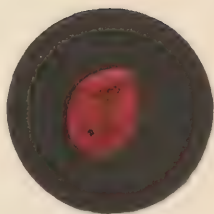
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G.

DISEASES AND INJURIES OF THE MEMBRANA TYMPANI, AND ACUTE OTITIS MEDIA,

INCLUDING PREVENTIVE HYGIENE.

BY GORHAM BACON, M.D.,

Aural Surgeon to the New York Eye and Ear Infirmary; Consulting Aural Surgeon to the New York Orthopædic Dispensary and Hospital, etc.

PART I.

DISEASES AND INJURIES OF THE MEMBRANA TYMPANI.

INJURIES of the membrana tympani are usually produced (1) by a sudden condensation of air in the external auditory canal or middle ear, (2) by a fracture of the cranial bones extending to the drum-head, or (3) by the penetration of some foreign body. Occasionally a rupture may be caused by the rapid rarefaction of the external atmosphere. This accident has occurred at times when a Siegle's otoscope has been used with a pump attached for exhausting the air in the auditory canal. It is probable, however, that when this occurs or when the membrana tympani is ruptured from the too forcible entrance of air in the middle ear from a Politzer bag, atrophic changes have occurred in the drum-head, so that it is unable to withstand the increased pressure.

More frequently, injuries of the membrana tympani occur in individuals who are in the habit of "scratching their ears" with hair-pins, tooth-picks, or ear-scoops to relieve a disagreeable itching, when accidentally the instrument is pushed in too far; occasionally the membrana tympani is entirely destroyed, followed by severe inflammation of the auditory canal from unskilful attempts made to remove a foreign body. Other causes are the instillation of strong solutions into the canal, boxing the ears, diving, the force of the waves striking against the ear while bathing, blows, discharge of cannon, gunshot wounds, a kick on the mastoid process, and judicial hanging. Occasionally the drum-head is ruptured during violent attacks of sneezing or vomiting and in whooping-cough.

Very seldom a rupture from indirect violence occurs in a normal ear. An examination of the membrana tympani in which the accident has oc-

curred will usually reveal a catarrhal condition of the middle ear, with more or less obstruction to the entrance of air through the Eustachian tube, or some atrophic or other change in the drum-head. Gruber¹ has shown by experiments on the cadaver that it is a very difficult matter to rupture a normal membrana tympani. He inserted a catheter into the Eustachian tube of a normal ear from a fresh subject, fastening the catheter by means of a stout thread. From the compression-apparatus he suddenly allowed air compressed four- or five-fold to pass into the Eustachian tube. He then tied the tube and inserted a gutta-percha plug, with a small tube passing through its centre, in the external auditory canal, and allowed the compressed air to enter. In neither of these experiments was he able to rupture the drum-head.

During the laying of the foundations of the Brooklyn Bridge, many of the men working in the caisson suffered from rupture of the drum-head. It was the belief of Dr. A. H. Smith,² the medical officer in charge of the men, that in all those who suffered from an aural affection after working in the caisson there already existed some obstruction to the entrance of air through the Eustachian tubes.

It has been suggested by some writers that the membrana flaccida, or Shrapnell's membrane, plays an important part in preventing a rupture, as it is less tense and gives way somewhat under pressure exerted upon it. Some have thought that the so-called foramen of Rivinus acts as a safety-valve, but Hyrtl has proved that it does not exist in the normal ear.

In direct injuries the point of rupture, according to Zaufal,³ who has made experiments on the dead body, is most frequently in the anterior half of the membrana tympani. Politzer's⁴ experience agrees with that of Zaufal, and he accepts the latter's explanation that the instrument in striking the drum-head slides off from the obliquely-placed posterior portion of the membrane, and consequently that portion is less frequently injured than the anterior portion.

In direct injuries the shape of the rupture will depend very much on the instrument causing it. Immediately after the injury to the drum-membrane by a sharp-pointed instrument, the rupture will be found somewhat round (see Plate I., Fig. B), and its edges usually covered with dark-red blood, and frequently there is more or less blood in the auditory canal, which may also be lacerated. The size and shape of the perforation often cannot be made out at the time, owing to the extent of the injury and the amount of extravasated blood. Usually, in direct injuries, inflammation of the membrana tympani and middle ear supervenes, and suppuration takes place.

Ruptures of the membrana tympani produced by indirect violence are

¹ Lehrbuch der Ohrenheilkunde, p. 310.

² Prize Essay, The Effects of High Atmospheric Pressure, including the Caisson Disease.

³ Archiv für Ohrenheilkunde, vol. viii.

⁴ Diseases of the Ear, p. 229.

usually due to blows or falls on the ear or to loud explosions. The rupture in these cases, according to Politzer,¹ is always gaping, so that the inner wall of the tympanic cavity can be seen. (See Plate I., Fig. C.) This wall is usually of a reddish-yellow color, in direct contrast to the bright-red color seen in middle-ear disease. The perforation is generally round or oval (see Plate I., Fig. C), with the long axis of the oval parallel with the direction of the radiating fibres. The most frequent seat of rupture is in the posterior portion of the membrane. As a rule, there is but one rupture. When the rupture is occasioned by a blow or fall, there may be concussion of the labyrinth at the same time, with considerable deafness, diagnosed by means of the tuning-fork, and it is in these cases, as well as in those where inflammation and suppuration have set in, that disturbances of hearing frequently remain after the rupture has healed.

CASE I.²—*Perforation of the Membrana Tympani from the Penetration of a Pencil.*—Rudolph J., German, aged twenty-nine, bookbinder, consulted me January 15, 1884, and gave the following history. That morning, while putting the end of a pencil into the right auditory canal to relieve itching, somebody ran against him and the pencil was pushed in too far. There was no pain at the time, but he became immediately very dizzy, and there was a noise like that of a drum, which has been present ever since; the dizziness lasted for about fifteen minutes, and when he sneezed he heard a whistle in the affected ear. There is some autophony. His general health is good, and he has never had any ear-disease before; uvula enlarged, as well as both tonsils, and he has chronic naso-pharyngeal catarrh. Hearing-distance, watch: right ear, $\frac{1}{48}$; left ear, $\frac{3}{48}$. Examination of the right ear showed that the inner end of the canal was congested. There was also a perforation of the membrana tympani in its posterior superior quadrant, covered with a clot of blood. There was congestion of the drum-head around the perforation involving half of the membrane; cone of light almost gone. Left ear: membrana tympani retracted, lustreless, and parchment-like; short process prominent, and cone of light very small.

CASE II.—*Rupture of the Membrana Tympani from a Blow.*—John H., aged fifty, Irish, 'longshoreman, came to me March 4, 1884. Says he has always been healthy, but subject to catarrh. When a boy, had some trouble with right ear, and a doctor applied leeches. Hearing has been good. No further trouble till last Thursday, when he was struck by a man's fist; immediately thought his head was broken, and felt a sting in the left ear and side of the head; he also experienced a buzzing noise at the time, but now it is less. He occasionally has a little pain in the ear. At the present moment there is a noise like the roar of the sea, but it is not always present. His voice sounds unnatural to him. He hears a noise in his ear when he blows his nose. This noise has been present since the accident. Hearing-distance,

¹ Diseases of the Ear, p 231.

² Bacon, Traumatic Lesions of the Membrana Tympani. New York Medical Record, April 11, 1885.

watch, $\frac{1}{4}\frac{5}{8}$ for both ears. Tuning-fork on vertex cranii heard, when vibrating, louder in the left ear.

Otoscopic Examination.—Left membrana tympani congested; oval perforation in posterior inferior quadrant, extending from near the umbo almost to the periphery of the membrane, and running parallel with the handle of the malleus; right membrana tympani parchment-like, short process prominent.

CASE III.—*Fracture of the Base of the Skull; Perforation of the Membrana Tympani.*—John E., aged sixteen, July 29, 1884. Five weeks before, patient had all the symptoms of fracture of the base of the skull, with bleeding from the right ear, nose, and mouth, and double facial paralysis. The latter has disappeared. He was treated at the New York Hospital in June and July, 1884. Since then he has been deaf, and there has been a purulent discharge from the right ear. No earache lately, and for the past few days no discharge. Hearing-distance, watch: left ear, $\frac{0}{4}\frac{8}{8}$; right ear, $\frac{1}{4}\frac{8}{8}$. Hearing not improved by Politzer's inflation; both Eustachian tubes pervious.

Otoscopic Examination.—Showed perforation of right membrana tympani.

CASE IV.—*Injury to the Membrana Tympani from an Unsuccessful Attempt to extract a Foreign Body.*—F. M., aged three, May 2, 1882. Brought to the infirmary, and the father said that the child had put something into his ear. He had taken him to a physician, who had made unsuccessful attempts to extract the foreign body with an instrument, but without any head-mirror. An examination showed that he had succeeded in lacerating the auditory canal and probably destroying entirely the membrana tympani.

CASE V.¹—*Injury to the Membrana Tympani from a Twig.*—A. M. O., aged forty-eight, a resident of New Jersey, and a farmer by occupation, came to see me April 21, 1885. He says that previous to this accident he never had any ear-disease, and that he has no hereditary tendency to deafness; he has always been a healthy man; when he takes cold, however, it generally "goes to his head."

Two months ago, when walking through the woods in Florida, a twig from the end of a bough penetrated the right auditory canal. He immediately felt a sharp pain, and everything seemed blurred for a few seconds; there was considerable bleeding from the canal, which continued for some time; the pain, which was sharp, recurred at intervals for a day, and a roaring noise in the ear "like that produced by a piece of wood slashing around in a pail of water," commenced soon after the accident, which noise, though worse at times, has been present ever since. The ear discharged a thin, watery fluid a day or two after the injury, the discharge continuing for three weeks. He says he was not dizzy after the accident.

¹ Bacon, Two Cases of Ear-Disease due to Traumatism. Transactions of the American Otological Society, and New York Medical Journal, September 4, 1886.

He did not consult any physician at the time, as there was none at hand, but put some laudanum into the ear. On returning to New Jersey, a physician there advised him to syringe the ear with tepid water and drop in sweet oil, this being all the treatment he has received up to the present time.

Otoscopic Examination.—The right membrana tympani is congested around Shrapnell's membrane and along the handle of the malleus, also very much retracted, with the posterior fold of the membrane and the short process very prominent; the cone of light is foreshortened, and there are several opacities in the lower part of the membrane. The left membrana tympani is fairly normal, although slightly opaque and retracted, and there is some congestion about the short process; the cone of light extends almost to the periphery. The patient has some chronic naso-pharyngeal catarrh.

Hearing-distance: acoumeter, right ear, six inches; left ear, nine feet; when a tuning-fork is placed on the vertex cranii, the sound is referred to the right ear; the aerial conduction is better for both ears than the bony,—that is, a vibrating tuning-fork is heard louder when held in front of each ear at a distance of two inches than when placed on the mastoid process. By Politzer inflation, air passes into both middle ears, but the right Eustachian tube is more pervious than the left one; there is also, after inflation, some bulging of the posterior inferior quadrant of the right membrana tympani, and the hearing-distance for the acoumeter is increased in the right ear to twelve inches and in the left ear to twelve feet.

CASE VI.—*Pistol-shot Wound of the Right Mastoid Process.*—Annie B., aged twenty-three, a native of the United States, consulted me February 10, 1885, at the New York Eye and Ear Infirmary. Before receiving this wound she never had any deafness or tinnitus. She is not subject to head colds, but is very anæmic in appearance. Last June, she says, a man, standing about six feet behind her, accidentally fired a pistol which he held in his hand, and the bullet struck her just behind the right ear. She did not become unconscious at the time, but suffered excruciating pain. She was taken to the Chambers Street Hospital and immediately put under ether. She did not notice that she was deaf till after she came out of the anæsthesia, and four days after this she first noticed a singing noise, which has been present at times ever since. She is more deaf and has more tinnitus during damp weather. She remained in the hospital about two weeks.

About four months ago, when putting a hair-pin in the right auditory canal to relieve an itching sensation, she ran the instrument against a hard object just inside the meatus. She was prompted to seek advice at the infirmary, because two nights before she had had a severe earache, and all the previous day some bloody matter came from the right ear; the deafness and noises have remained about the same as at first; she feels the same numb feeling in the ear which has been there since the accident.

Otoscopic Examination.—The left membrana tympani is dull, very much retracted, and thickened.

The right membrana tympani not seen, as the canal contains a loose sequestrum of bone, and there is a bulging of the posterior wall; the protuberance or bulging commences just inside the meatus; the anterior wall of the canal is inflamed. There is a cicatrix over the mastoid process about one inch long, half an inch behind the auricle, the depression where the bullet entered being on a level with the upper wall of the auditory canal and about three-quarters of an inch behind the attachment of the pinna. Hearing-distance: acoumeter, right ear, 0; left ear, almost normal.

A tuning-fork on the vertex is not heard with either ear, but when placed against the teeth is a little louder in the right ear. The bony conduction is better than the aerial in the right ear, and *vice versa* for the left ear.

Operation.—Ether given by the resident surgeon, Dr. Walker. The sequestrum of bone lying in the canal was removed. The swelling on the posterior wall of the canal, round and hard, had every appearance of being the bullet beneath the lining membrane of the canal. An incision was made through the tissues covering this protuberance, but it proved to be necrosed bone; several pieces of bone were removed from the posterior wall, so that an opening was made through to the mastoid cells; some lead came away also. The hemorrhage being profuse and the opening so small, it was considered advisable to trephine the mastoid. Some more pieces of bone were removed through this opening behind the auricle. The bullet was firmly embedded in the mastoid cells, lying against the inner wall of the mastoid cavity close to the antrum; it was very much flattened out and firmly adherent. The patient's pulse suddenly becoming very weak, further procedure was stopped, as she had been under ether for some time. The mastoid cavity and the surrounding parts were washed thoroughly with a solution of bichloride of mercury (one to one thousand), and iodoform insufflated and a plug of lint inserted in the opening made by the trephine.

February 13.—No pain in the ear; it hurts her to open her mouth in eating; no headache nor any bad symptoms; the canal is somewhat inflamed near the external meatus. The cotton was partly removed from the wound over the mastoid and the sinus through the posterior bony auditory canal, and the parts were syringed as before with the bichloride solution and dressed with iodoform. The hearing-distance improved to six inches for the acoumeter, and she hears the cars passing the door now, which she could not do before the operation. The bullet is seen through the mastoid opening close to the antrum and firmly adherent. Any attempt to remove it causes great pain and could not be repeated without again giving the patient ether, which she refuses to have done.

The patient refused to remain any longer in the hospital, but promised to return in a few days and have the bullet removed. She came back, but said her friends would not allow any further operation.

February 16.—Temperature, 99.5° F. at 5 P.M.; same dressing as before; any attempt to remove the bullet ineffectual, as it caused too much

pain; some lead was cut and scraped from the remains of the bullet several times, and the patient was treated as an out-door patient. No membrana tympani can be discovered in the right canal.

March 10.—Hearing-distance, acoumeter, thirty inches. The tuning-fork on the vertex is heard better in the left ear, also when placed on the teeth; the aerial conduction is better than the bony; the bulging of the canal is less; less discharge also; the mastoid opening has nearly closed; same treatment continued.

The patient was not seen again after March 10, as she disappeared, nor could any trace be found of her. Very little could be done for her after she left the infirmary as an in-door patient, as she was a woman of bad character, who drank to excess, and was very much broken down in general health. When last seen the sinuses through the posterior bony auditory canal and behind the auricle were closing rapidly, and the discharge had become slight.

CASE VII.¹—*Concussion of the Labyrinth (probably) from a Fall.*—John R., aged nineteen, January 13, 1885. Five days ago, after drinking freely, the patient fell, striking against the right side of his forehead and right ear. There was no bleeding from the ear. He was carried home, and was not able to get up till the following day. The day after the fall he noticed that he was deaf in the right ear, and the hearing has not improved since then. He has been annoyed by marked whistling or singing tinnitus. There is no pain in the ear or head. The day after the accident, on trying to walk, he staggered and had to catch hold of a support to keep from falling. At the same time he felt dizzy and light-headed. The dizziness is felt every time he starts up quickly or tries to walk, but not when he keeps still. The staggering also has kept up ever since until to-day, when he was able to walk pretty well.

An examination showed the left membrana tympani somewhat hazy and retracted. Right membrana tympani is hazy and retracted, and has a peculiar corrugated appearance in the posterior superior quadrant. Acoumeter: right ear, 0, before and after Politzer inflation; left ear, eight feet. Tuning-fork, when placed in different positions on the head, heard better in the left ear, although still audible in the right ear. Air does not reach the right middle ear by Politzer inflation; catheter used. The patient has chronic naso-pharyngeal catarrh and bad teeth.

CASE VIII.—*Rupture of the Membrana Tympani from a Blow.*—Mary R., aged twenty-four, was seen October 27, 1885. She says that since childhood the right ear has been discharging, and she has been deaf on that side. Ten days ago she was struck across the left ear with the palm of the hand. She had some pain for a moment, was dizzy, and noticed that she had suddenly become deaf. The deafness has continued until now, but she has had no more pain, and no tinnitus or discharge. There is a stopped-up

¹ Bacon, A Report of Twenty-one Cases of Traumatic Lesions of the Ear. New York Medical Journal, May 7, 1887.

feeling in the ear. She picked the ear with a hair-pin, which made it bleed and ache. She then washed out the ear with a lotion obtained from an apothecary.

Hearing-distance: acoumeter, left ear, twelve feet; König rod, thirty thousand v. s., right ear, forty-two inches, left ear, eight inches. Bone-conduction better on the left side. Left Eustachian tube not very pervious. Nasal passages contracted and the post-nasal tissues spongy.

Otoscopic Examination.—Right membrana tympani, anterior half gone and surface granular.

Left membrana tympani congested and much retracted; short process prominent; calcareous deposit just below the latter. There is a depression in the posterior portion of the membrana tympani, in the centre of which is a linear perforation occupying the posterior inferior quadrant. In front of this is a very small perforation.

CASE IX.—*Deafness from being hit by a Snow-ball.*—Samuel F., aged nine, was seen December 10, 1886. Says he had an earache a month ago in the left ear. He is a catarrhal subject. He further says that day before yesterday he was hit by a snow-ball on the left ear, and he immediately noticed that he was deaf on that side; there has been no pain nor tinnitus. Hearing-distance, watch: right ear, two and a half feet; left ear, one and a half inches.

Otoscopic Examination.—Right membrana tympani fairly normal; slightly retracted. Left auditory canal slightly congested; membrana tympani slightly congested and somewhat more retracted than the right drum-head. After Politzer inflation the hearing-distance for the left ear was increased to six inches.

H. Nimier,¹ surgeon-major, has formed some conclusions on the effects of the discharge of fire-arms upon the ear, of which C. H. Burnett has made an abstract.² The conclusions are,—

1. The detonation caused by the discharge of fire-arms is a complex noise caused by: *a*, the vibrations of the barrel of the piece, excited by the passage of the projectile; *b*, those resulting from the transmission of movement to the accessory parts of the weapon and to neighboring objects; *c*, those excited in the projectile itself at the moment of its leaving the barrel of the piece, in which it has been rubbed; *d*, the actual waves of sound caused both by the projectile in its passage and by the deflagration of the charge.

2. The effect of the discharge of fire-arms upon the ear results, in most cases, not from the shock of the explosion of gases, but from the action of sonorous waves transmitted to the membrana tympani and all of the acoustic apparatus.

3. The popular practice of looking towards the mouth of the cannon, and

¹ Archives de Médecine et de Pharmacie Militaires, No. 7, July, 1889.

² American Journal of the Medical Sciences, September, 1889.

of slightly separating the jaws and lips at the time of the discharge, as well as the want of confidence in the utility of a tampon of cotton in the ears, are in accordance with the views of the author.

4. The discharge of fire-arms can produce, besides rupture of the membrana tympani, deafness and subjective noises and various functional disturbances of a reflex nature, especially in the sphere of the bulbar nerves.

Prognosis.—The prognosis in these cases of traumatic lesions of the ear depends very much on the nature and cause of the injury. Direct injuries to the canal and membrana tympani from the introduction of hair-pins, etc., into the meatus, may cause but slight inflammation in many cases, and may heal leaving but little deafness. Injuries to the drum-head from sharp-pointed instruments usually heal rapidly, if inflammation of the middle ear does not follow. Inflammation and suppuration of the middle ear may occur, where the canal or membrana tympani has been injured, and become chronic, or various complications may arise, making the prognosis serious. When thickening of the drum-head, with adhesions, has taken place, or there exists concussion of the labyrinth with or without rupture of the membrana tympani, permanent disturbances of hearing usually remain.

Injuries to the ear from blows, falls, etc., on account of their medico-legal significance, become of special interest to the otologist, who is frequently asked to give his opinion in court as to whether the hearing has been injured by such accidents.

In order to decide if a rupture is of traumatic origin, it is necessary to examine the membrana tympani immediately after the supposed accident, as in indirect injuries the edges of the rupture are sharply defined and covered more or less with dark-red coagulated blood. (See Plate I., Fig. C.) If the perforation be a large one, the inner wall of the middle ear will show through, of a yellowish-pink color. If suppuration have already taken place at the time of the examination, it will be impossible to decide that the case is one of traumatic origin. An important point made by Politzer, in deciding whether the rupture of the membrana tympani is due to traumatism, is as to the character of the sound made by the air in passing through the orifice of the rupture, on inflation of the ear by the Valsalvan method. In cases where the perforation has been caused by disease of the middle ear, even where there has been much loss of substance, the air rushes out with a sharp hissing noise, while in a normal ear which has been ruptured by traumatism the escaping air has a broad, deep-breathing sound.

In cases of labyrinthine disease, where the aurist is called upon to determine whether the deafness is due to a blow or fall, etc., and the membrana tympani and external meatus appear normal, a positive diagnosis cannot be made, for in these cases the question depends upon the answers given by the patient when his hearing is tested with the tuning-fork and König rods. The perception of sound by bony conduction becomes much diminished or is quite wanting in such cases, and the patient is apt to complain of subjective noises, giddiness, deafness, and a dull feeling in the

head; but the fact must not be overlooked that catarrh and other diseases may give rise to similar symptoms.

In a suit for damages reported by Dr. Roosa and myself¹ several years ago, it was alleged that the deafness in the plaintiff's case had been caused by a blow on the ear. The suit arose from the fact that Mr. X., the defendant,—seeing his children frequently maltreated by the plaintiff's boy, Master Y., who was older than his children,—struck the plaintiff's child across the cheek, while his parents were absent, and when he was left in charge of a colored nurse; who testified that Mr. X. made a sudden attack on the boy while he was at her side, that he struck him such a severe blow that the boy fell over against her, and that he was ill for several days, and complained of pain about his ear.

The plaintiff produced four or five witnesses, who testified that they had frequent opportunities of observing Master Y. up to the summer of 1883, when he left town, and that they had observed no difficulty with his hearing.

On the other hand, the defendant, Mr. X., testified that the plaintiff's boy, Master Y., made a sudden attack on his child, who had been ill and had been carried out to a place on the lawn. He heard his child scream, and found him lying on the ground and panting and very blue in the face. He could not find Master Y. at that time, but about half an hour afterwards he was brought up to him by the colored nurse, for punishment, as he supposed. He gave him a slap on the left cheek, which did not stir him an inch. The defendant further testified that he did it simply to protect his children.

The testimony of other witnesses was to the effect that the boy was playing around as usual all that day, and that he seemed to be as well as ever. A gentleman in the hotel, who was in the habit of being frequently with the children, said that before the boy was slapped he noticed that Master Y. at times did not hear well and he had to repeat his questions to him; also that the boy was in the habit of frequent bathing and remaining in the water a long time.

I made an examination of the boy's ears, and found that he was a mouth-breather; that he heard better on dry, clear days; that he was subject to "head-colds," which usually affected the ears. He was anæmic, poorly nourished, and had a dazed or stupid appearance. He was a subject of chronic naso-pharyngeal catarrh, with hypertrophy of the tissues in the nasal passages. The left nasal passage was more obstructed than the right, the septum nasi deviating to the left side. There was chronic pharyngitis, with thickening of the palatal folds; uvula elongated. Tonsils not enlarged. Right membrana tympani congested and swollen; epidermal layer sodden and coming off, also from inner end of the canal. Left

¹ Bacon and Roosa, An Account of a Suit for Damages in a Case of Alleged Injury by a Blow on the Ear. New York Medical Journal, December 12, 19, 1885.

membrana tympani presented almost the same appearances, though less congested. No perforation seen in either ear. Hearing-distance for the watch: right ear, contact; left ear the same. When close to him, he heard loud voice in the right ear and very loud voice in the left one. The bony conduction was much better than the aerial for both ears, as shown by the tuning-fork test. After inflation by Politzer's method, the hearing-distance was much improved, and the difference in hearing-power between the two ears was much less marked.

Both Dr. Roosa and myself testified that the case was one of deafness due to catarrh, and that the blow had nothing to do with the deafness. The plaintiff secured a verdict for four hundred dollars, eleven of the jury being in favor of acquittal.

As a compensation for loss of hearing, this amount was, of course, entirely inadequate. It is probable, therefore, that the jury was convinced that no damage to the ears resulted from the blow. The physician for the plaintiff said nothing in his testimony that could contradict this view. He simply testified that he treated the child—whom he saw for the first time long after the incident which caused the suit—for catarrh of the nose, of the pharynx, and of both middle ears. By far the greater weight of evidence went to show that the boy was struck on the cheek once, not sufficiently hard, however, to move him from a perpendicular position, and not on the ear; that he soon ate his dinner and appeared as usual. A blow on the cheek of sufficient violence to hurt the ear would have certainly moved the boy and probably have knocked him down. It would also have caused dizziness and other symptoms than those complained of. It was shown that he was at a sea-side resort, in the habit of bathing and diving and remaining in the water for long periods at a time; that at the time of the slap both parents were away and the boy was in charge of a nurse, who was the principal witness for the plaintiff as to the nature of the blow. Nothing is more unreliable and misleading, if trusted, than the testimony of patients and patients' friends as to the causation of disease. The lawyer, as well as the physician, knows that the facts and an interested person's account of them are sometimes entirely at variance. When it comes to deductions drawn from facts the non-expert mind will inevitably fall into error. We are very often obliged as physicians to give very little credence to the history of cases, but lawyers frequently seem as credulous as laymen in regard to theories of the causation of disease and the value of the testimony upon which these theories are based.

Fortunately, in the examination of the ear we have, in the speculum, the otoscope, and the tuning-fork, aids to diagnosis which enable us to look at cases with considerable objectiveness. If a patient came to us with the statement that, while hearing well, he received a blow on the ear which caused tinnitus, pain, and perhaps vertigo; that he soon found his hearing defective in that ear, and that it was growing worse; if we examined the drum-head and found no lesions, and yet the patient's hearing was impaired

on that side, and the tuning-fork was heard better through the air than through the bones, we should conclude that the history was correct, and that he was suffering from concussion of the nerve or labyrinth, the result of a blow. But when a disease is found that is not likely to have resulted from a blow, certainly we should not necessarily conclude that it had been so caused, no matter how strongly the patient's friends might insist upon it. Expert testimony, as now given by physicians chosen by the counsel and not by the court, and before a jury of laymen, is often of no value, and sometimes brings the medical profession into disrepute and, what is worse, defeats the ends of justice. Medico-legal cases should be settled by juries of medical men, and experts should be witnesses called and paid by the state.

Treatment.—In all cases of simple rupture of the membrana tympani from traumatism, the instillation of drops and syringing the ear should be carefully avoided. It may be necessary in severe cases to keep the patient quiet in his room and on a low diet, while in mild cases he may attend to his usual business, but it is well to have him keep a piece of cotton wool in the affected ear. When the case develops into one of inflammation of the drum-head and middle ear, followed by suppuration, the same treatment should be carried out that is given under the head of acute catarrhal and acute purulent otitis media.

In some cases of concussion of the labyrinth the hearing-distance will be improved and the tinnitus will become less under the application of a constant electric current, while in others nerve tonics may be recommended with benefit. In patients suffering from concussion of the labyrinth, permanent disturbances of hearing and subjective noises will remain occasionally in spite of all treatment.

FRACTURE OF THE HANDLE OF THE MALLEUS.

This rare accident has been described by R. F. Weir,¹ Ménière, Von Troeltsch, and lately by N. J. Hepburn.² Weir's case was that of an Irish laboring-man, who fell from a height of fifteen feet some four months before he was seen by Dr. Weir. The fracture occurred in the malleus, just below the short process, and upon inflation it was seen to be ununited.

Hepburn reported a case in which the accident occurred by thrusting a hair-pin into the meatus and through the membrana tympani of a man who was feigning sleep, and whose little son was tickling his ears in the endeavor to awaken him. He experienced severe pain in the left ear at the time, and there was some hemorrhage. The pain was not of long duration, and the sanguinolent discharge disappeared in the course of a week, but the hearing, which was said to have been perfect before the accident, was nearly abolished.

¹ Transactions of the American Otological Society, vol. i., 1870.

² Ibid., vol. iv., Part IV., 1890.

On examination, the membrana tympani presented a sunken appearance; the short process was very prominent and the malleus handle apparently twisted. No opening was visible in the membrane, but a curious line extended obliquely across the malleus handle from below upward and backward near its extremity. On inflating, there appeared a false point of motion where this line crossed the bone. The diagnosis of fracture was made. Hearing-distance, watch, one-half inch. Seven months later, an examination showed that the slit-like cicatrix had become an oval opening, and the club-shaped end of the malleus handle had almost disappeared. Through the opening in the drum-membrane could be seen a dislocation of the incudo-stapedial joint, which had probably occurred at the time of the accident. The bones in sight were necrosed. The patient declined to have them removed, and treatment ceased.

Theobald,¹ of Baltimore, reported an unusual form of dislocation of the malleus handle at the annual meeting of the Otological Society in September, 1891. The history of the case was as follows. The patient, a lady about forty years of age, was decidedly deaf in the right ear from chronic catarrh of the drum, and in the left ear as the result of old otitis media. The right ear presented nothing worthy of note. The left ear exhibited signs of having been at one time the seat of severe inflammation; the posterior half of the tympanic membrane had evidently been extensively destroyed, and, although the membrane had reformed, the cicatricial portion was uneven, depressed, and probably more or less adherent to the inner wall of the tympanum. The short process of the malleus was not discernible. The handle, which was completely severed from the body of the bone, was adherent to the tympanic membrane only at its tip and for a short distance above this point, while its upper two-thirds projected forward and outward into the auditory meatus, the free end lying nearly in contact with the anterior wall of the canal. The projecting portion, somewhat curved in form, was very white, except at its free extremity, which was of a brownish color, the effect of this peculiar coloring being such as to suggest a resemblance to a diminutive stalk of asparagus.

Epithelial Growths on the Membrana Tympani.—Under the heading of wart-like bodies of the membrana tympani, C. H. Burnett² describes the case of a man aged twenty-four, in which he found two pale-yellow warts about a millimetre in diameter on the upper and posterior quadrant of the membrana tympani. He could find no explanation for their occurrence, unless it was caused by the instillation of various fluids which the patient on his own responsibility had used for some time for the cure of deafness resulting from chronic catarrh of the middle ear. Burnett says that the constant irritation thus applied to the delicate dermoid layer of the drum-head may have provoked the growth of some of its papillæ into the above-

¹ Transactions of the American Otological Society, vol. v., Part I., 1892.

² Treatise on the Ear, p. 345.

named wart-like bodies. Urbantschitsch¹ was the first to describe this rare form of disease, in which he found these growths to consist only of epithelial cells.

Politzer² describes a case where eight pearly balls of the size of a pin's head and of a bright lustre, joined to one another in the form of a semicircle with its concavity downward, proving, when probed, to be firmly-seated, solid globules, were to be seen in the posterior portion of the membrane. These growths, consisting of cholesterin crystals and molecular débris, had developed in the course of suppuration of the middle ear, which had existed for a year, and which had ceased only a short time before the examination.

Tubercles in the Membrana Tympani.—Tubercles appearing as reddish-yellow spots about the size of a pin's head are occasionally seen in miliaary tuberculosis.

POLYPI, GRANULATIONS, AND ANGIOMATA ATTACHED TO THE MEMBRANA TYMPANI.

Granulations are occasionally observed on the membrana tympani in cases of chronic myringitis and acute purulent otitis media, but it is in chronic middle-ear disease that both granulations and polypoid growths are most frequently observed. A polypus arising from the membrana tympani itself is usually attached to some portion of the posterior superior quadrant. Polypi may be attached to other portions of the membrane, however, and at times the ossicles are found embedded in the growth, most frequently the malleus.

Polypi are divided usually into four varieties,—viz., I., mucous polypi (granulations or round-celled polypi); II., fibromata; III., myxomata; and IV., angiomata. Mucous polypi are those of most frequent occurrence. They are generally somewhat irregular on the surface, due to the glands and papillæ. The outer side of the polypus, or that exposed to the external air, is usually covered with pavement epithelium; while on the inner surface, or the unexposed side, the epithelium is of the cylindrical or ciliated cylindrical variety. Mucous polypi are due to a hyperplasia of the mucous membrane, and are composed of a delicate and fine stroma of areolar connective tissue, which contains in its meshes round cells and occasionally stellate or spindle-shaped cells.³ (See Fig. 1.)

The second variety—viz., fibromata—are much more dense than mucous polypi. They contain fewer blood-vessels, and consist of a firm fibrillar connective tissue in the meshes of which are found spindle cells.

An angioma attached by a long and slender pedicle to the stump of the malleus, in a case of chronic purulent otitis media, has been reported by Buck.⁴ The growth, when examined microscopically, was found to consist

¹ Archiv für Ohrenheilkunde, Bd. x. S. 7.

² Diseases of the Ear, p. 210.

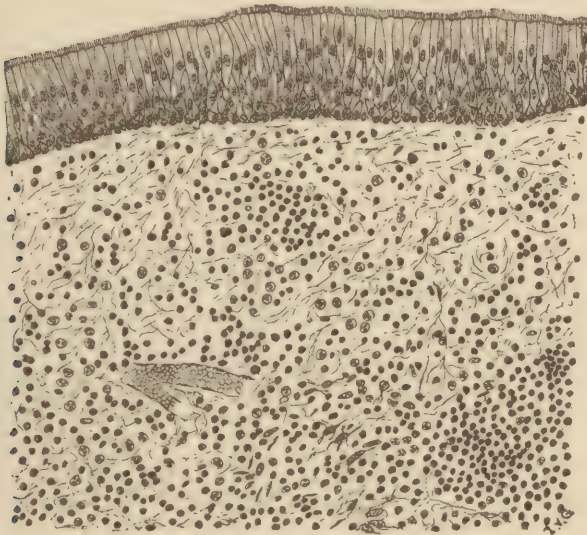
³ From Buck's Reference Handbook of the Medical Sciences.

⁴ Transactions of the American Otological Society, 1870.

of blood-vessels radiating from an irregularly-shaped central cavity, and separated by a net-work of fibrous connective tissue holding blood-corpuscles in its meshes. In two or three of the sections a large vein could be followed from the central cavity into the remaining stump of the pedicle. In one of these and in other sections, the point of rupture could be distinctly traced from the central cavity to the periphery of the polypus.

Huntington Richards¹ recently reported a similar case where the

FIG. 1.



Section of mucous or round-celled polypus.

angioma was seemingly attached to the outer surface of the drum-membrane, close to the prominence of the short process of the hammer. The patient, a child six years of age, was brought to the New York Eye and Ear Infirmary to be treated for a profuse and badly-smelling otorrhœa unaccompanied by pain, and dating, according to the mother's statement, only from the preceding February. An examination of the ear revealed the presence of a polypoid mass of considerable size, almost occluding the lumen of the external auditory canal, and of a deep purplish-red color. A considerable portion of the tumor was removed by the snare at the first visit, and on the following day the remainder of the growth was extracted, leaving a minute stump of the pedicle, which was cauterized with chromic acid. The drum-membrane was of a dark, dull-reddish color.

Treatment.—Polypi and granulations, when small in size, may be touched with a drop of tincture of chloride of iron, or with nitrate of silver or chromic acid fused on the end of a probe. When of large size and when attached by a pedicle, the snare (Blake's, Fig. 2) will be necessary for their

¹ Transactions of the American Otological Society, vol. iv., Part II., 1888.

removal. The root or stump of the pedicle should be cauterized after using the snare. Great care should be exercised, in using chromic acid, that nothing but the growth is touched.

Curettes are extremely useful in some cases. (See Fig. 3.)

FIG. 2.



Blake's snare.

FIG. 3.



The sharp curette.

Hyperæmia, Hæmatoma, Hemorrhage.—Blood-vessels are not usually noticed in the examination of the normal drum-membrane. When the auditory canal or drum-membrane is touched by a probe, we can generally produce a temporary hyperæmia along the handle of the malleus. When there is a permanent congestion of these vessels, the condition is a sign of inflammation of the auditory meatus, membrana tympani, or tympanic cavity, or else a symptom of habitual congestion of the head.

Hæmatoma, first described by Wendt,¹ who found it during the dissection of small-pox cases, appears as a round or oval swelling, sharply defined and of a bluish-red color.

Hemorrhage in the substance of the drum-membrane may occur as minute ecchymoses, superficial extravasations, hæmatomata, and hemorrhagic infiltrations (Schwartz),² and may take place either in the layers of the mucous membrane or the dermal layer, or in both. This condition is sometimes found in acute inflammation of the membrana tympani or of the tympanum, especially during epidemics of influenza; also when there

¹ Archiv für Heilkunde, xiii. S. 128.

² Pathological Anatomy of the Ear, p. 62.

is hyperæmia simultaneously of the mucous membrane of the middle ear in cases of small-pox, typhus fever, scurvy, etc.

Vesicles containing blood are occasionally found on the drum-head in an inflammation of the external meatus which Politzer classifies as otitis externa hæmorrhagica. The condition seems to be one of superficial inflammation of the dermal layer. I have reported five cases¹ of the disease, in one of which there was an elongated hemorrhagic vesicle extending from the cartilaginous portion of the auditory meatus over the posterior wall of the bony portion and spreading over the posterior superior quadrant of the drum-head.

Miscellaneous Conditions of the Membrana Tympani.—Diseases of the skin affecting the meatus frequently extend to the drum-membrane, on the surface of which we occasionally see vesicles of pemphigus and eczema.

Opacities, thickenings, and atrophic changes in the membrana tympani usually occur as a result of chronic catarrhal or purulent inflammation of the middle ear.

Calcifications of the drum-membrane are sometimes seen as independent affections when the hearing is normal and the middle ear is not involved, but they are more commonly found in cases of chronic purulent otitis media, though they may occur in the non-suppurative form.

Cholesteatomata of the membrana tympani have been reported by Wendt,² Küpper,³ and others, but they are rarely seen.

ACUTE MYRINGITIS.

The drum-head may be affected in part only or in its whole extent, but, according to Politzer,⁴ the signs of inflammation are generally most marked in the posterior part of the membrane. It has been said by some writers to be caused by a cold wind blowing on the ear, or by a cold bath; according to others, by an extension of inflammation from the nasopharynx, in which case the middle ear would be involved as well. Sea-bathing is also mentioned as a cause.

When examined in the first stage, there will be found considerable hyperæmia, with an effusion later on. In some cases there will be less hyperæmia or simply an effusion of serum in the dermal layer. There may be slight effusions of blood in this layer, or there may develop small vesicles filled with serum. These vesicles are usually absorbed, but they may burst, in which case a slight serous discharge from the meatus will occur. As a rule, the dermal layer is the only one involved, but in the more severe forms of inflammation, abscesses in the deeper portions of the membrana tympani may follow, when it will become more difficult to diagnose this form of inflammation from an otitis media acuta.

¹ Otitis Externa Hæmorrhagica, Archives of Otology, vol. xix. No. 1, 1890.

² Archiv für Heilkunde, 1873, S. 551.

³ Archiv für Ohrenheilkunde, Bd. xl. S. 18.

⁴ Diseases of the Ear, p. 218.

Symptoms.—The symptoms are moderate pain in the ear in the less severe cases, but a stinging and sharp pain in the severe form, attended by deep abscess. Sometimes the patients complain of a pulsating noise and more or less tinnitus. There is apt to be much less difficulty in hearing in these cases than in those where the middle ear is involved, and the course of the disease is usually much shorter in duration, in some cases lasting but four or five days. Frequently, acute myringitis is associated with acute otitis media, or, beginning as such, is followed by the latter, so that in many cases it will be difficult to separate the two. Politzer¹ says that we are justifiable in assuming a primary inflammation of the membrana tympani when, in spite of the bulging outward of the membrane, the hearing-distance is not noticeably decreased.

In the mild forms of acute myringitis, recovery is usually the result. It may become chronic, when suppuration will occur from the outer layer of the membrane, or the middle ear may be involved. In the milder cases, and in those where there are vesicles, the membrane will have a macerated and dull appearance after the acute stage or when the vesicles burst. More or less of the dermal layer peels off, and there will be some hyperæmia of the drum-head, which condition gradually disappears.

Treatment.—In the very acute cases, antiphlogistic measures—viz., wet cupping, etc.—will be necessary. In the case of superficial vesicles, they will usually burst of themselves, while it will be necessary frequently to puncture those seated in the deeper layer. For further treatment the reader is referred to the article on acute otitis media.

CHRONIC MYRINGITIS.

This is an extremely rare form of disease, and many writers deny its existence, because an inflammation commencing in the membrane as an acute inflammation is either cured as such or the middle ear or the external meatus is apt to be involved. It may follow an acute myringitis, when there is apt to be a continued suppuration and loss of the dermal layer. In some cases granulations develop.

Politzer² has observed repeatedly in diffuse acute and chronic inflammation of the external meatus, in which the external surface of the membrana tympani was also affected, inflammation and secretion continuing on the membrane after the inflammatory signs on the walls of the meatus had completely disappeared. He has also seen the signs of a chronic inflammation remain in the membrana tympani after the cessation of suppuration in the middle ear and after the closure of the perforation in the membrane. The latter forms cannot be classed among the primary inflammations, but after the disappearance of their cause, they may be considered as independent affections.

¹ Diseases of the Ear, p. 223.

² Ibid., p. 225.

In chronic myringitis a portion or the whole of the drum-head may be involved. The dermal layer, which has a macerated appearance, usually peels off, disclosing a more or less congested membrana tympani, especially along the handle of the malleus. Ulcerations are sometimes seen.

In order to make a diagnosis of chronic myringitis, it is necessary to exclude otitis media. The case must be under observation for some time, and by Politzer inflation, or the use of the catheter, we can determine whether a perforation exists. In both acute and chronic myringitis the deafness is much less marked than in diseases of the middle ear. Usually very little pain is complained of, the greatest annoyance being the disagreeable odor from the discharge, and there is but little tinnitus. In some cases, especially those of a very chronic nature, there is apt to follow more or less thickening of the drum-head, with disturbances of hearing.

Treatment.—It will be necessary to syringe the canal if there is much secretion, and particularly if offensive, when it will be well to use a solution of bichloride of mercury, one to five thousand. After carefully drying the meatus with absorbent cotton on a cotton-holder, I generally insufflate a powder composed of equal parts of boracic acid and oxide of zinc, as recommended by Theobald, of Baltimore, for chronic suppurative otitis media. If this should not succeed, other powders, as iodol, bismuth subiodide, iodoform, etc., recommended for chronic suppuration of the middle ear, can be used. Some otologists prefer astringent solutions, such as zinc sulphate, copper sulphate (gr. ii-iv- $\frac{3}{4}$), or solutions of lead. Where granulations exist, it will be necessary to touch them with a drop of tincture of chloride of iron or with nitrate of silver or chromic acid fused on the end of a probe.

PART II.

ACUTE OTITIS MEDIA, INCLUDING PREVENTIVE HYGIENE.

Although writers generally distinguish two varieties of acute inflammation of the middle ear,—viz., acute catarrhal and acute suppurative otitis media,—yet it is extremely difficult in some cases to make any distinction. We will first consider what is generally called

ACUTE CATARRHAL OTITIS MEDIA.

There is in this disease at first more or less hyperæmia and swelling of the lining membrane of the middle ear and that covering the ossicles and inner surface of the membrana tympani. It is also probable that the mastoid cells in a great many, if not in all, cases of this disease are subject to the same changes. After the hyperæmia, there is usually more or less exudation of serum and exudation cells. There may be ecchymoses in severe

cases. The epithelium lining the cavity is more or less peeled off and macerated. As a rule, the Eustachian tube is greatly swollen. The tympanic cavity usually contains thick mucus, pus-cells, and numerous red blood-corpuscles. In some cases, there may be a great preponderance of pus-cells, while in others, the discharge may be almost wholly of mucus of a tough and stringy nature, requiring to be removed with forceps. This variety is one of the most difficult to cure.

This is the form of inflammation that is commonly called "earache" in children, and generally proceeds from a "cold in the head." Some children are subject to frequent attacks, which are extremely painful, and very often there is no perforation. This disease is most commonly seen during the winter and spring months, when great and sudden changes in temperature are most frequent. During the past three winters, on account of the epidemic of influenza, there has been a great number of these cases.

Causation.—This form is due most frequently to a pharyngitis and "cold in the head" which usually follows sudden atmospheric changes. Other causes are long exposure to wet and cold, sea-bathing, sitting in a draught with the air blowing against the ear. It may occur in the course of the acute infectious diseases, such as measles, scarlatina, whooping-cough, diphtheria, and in pneumonitis, bronchitis, tuberculosis, puerperal fever, cerebro-spinal meningitis, and syphilis.

The use of the nasal douche as a cause of this disease, first mentioned by Roosa, I have since observed in numerous instances. In some instances, where the advice to "sniff up" salt-and-water for nasal catarrh has been given, acute inflammation has resulted from the fluid entering the Eustachian tube and middle ear.

Teething children are subject to attacks of catarrhal otitis media with earache, which very frequently runs into the acute purulent form, with perforation of the drum-head. The nervous supply of the middle ear and the teeth must be constantly borne in mind, on account of their intimate relationship. It is well always to examine the teeth in cases of acute otitis media, to see if there be any irritation present from decayed roots. The eruption of molar teeth is frequently preceded by this form of disease, as well as by acute suppurative otitis media. One ear or both ears may be affected at the same time.

It is a well-known fact that sea-bathing is a frequent cause of ear-disease. Not only may the membrana tympani be ruptured in diving or from the force of the wave striking against the side of the head, but an acute otitis media catarrhalis may follow. The cold water entering the auditory meatus may set up an inflammation of the canal and drum-head and induce a tendency to chronic dermatitis and periostitis of the parts. Occasionally the mastoid is affected, from an extension of the inflammation. Still further, an acute otitis media may occur from water entering the middle ear through the Eustachian tube. I believe this to be frequently the explanation of an earache from sea-bathing, as surf-bathers are especially

liable to have water enter the mouth and nasal passages. An acute catarrh of the middle ear is undoubtedly caused also in cold-water bathing, from sudden chilling of the surface of the body when overheated, or from remaining in the water for a protracted period. Children should be especially forbidden to "duck the head," as this frequently is the cause of a catarrhal otitis media; and to prevent as much as possible a liability to ear-disease while sea-bathing, the person should be careful to keep the head above water, and the auditory canals should be closed with non-absorbent cotton or wool.

Burnett¹ says that "it is noteworthy that no mammal but man goes voluntarily under water without being provided with a means of preventing the water from running into the ears. It is a fact well known to many that hunting-dogs taught to dive become deaf."

Symptoms.—These will depend very much on the intensity of the inflammation. When following a "cold in the head," there may be experienced at first a dulness or fulness in the ear, but this is soon succeeded by a sharp, stinging, lancinating pain, intermittent at times, and usually more severe at night. Infants frequently scream and put the hand up to that side of the head. The writer has known of some cases where the general practitioner has suspected meningitis, until an examination of the ear disclosed the seat of the trouble. At the commencement of the disease there may be a severe headache.

The pain is not always complained of in the ear itself, as it often radiates about the ear and over the side of the head, extending in front of the ear, below the lobule, and at times shooting towards the teeth. Patients frequently speak of pain, on opening the mouth, around the condyle of the inferior maxilla. This form of disease is attended by some fever in a certain number of cases, more especially in children; delirium and convulsions are also sometimes observed in the latter.

The pain complained of is much less severe than that in acute purulent otitis media, which is one of the diagnostic points between them. The pain may be due to the inflammation itself, or, the mouth of the Eustachian tube being closed, to a direct pressure exerted on the parts by the products of inflammation. In children, however, where we find a catarrhal condition in the nose extending to the Eustachian tube, and preventing the entrance of air to the middle ear, the pain is due to the atmospheric pressure on the external surface of the drum-head, causing great retraction of the membrana tympani, the air in the middle ear having been absorbed. If not relieved by Politzer inflation and proper treatment applied to the nasopharynx, inflammation of the middle ear is likely to follow.

Patients frequently complain of pain on eructation, also during coughing or sneezing, and occasionally while talking. In the milder cases the pain is of short duration, but in the more severe forms it lasts several days,

¹ Treatise on the Ear, p. 452.

and during recovery more or less fulness and pressure about the ear are complained of.

Noises in the ear, or tinnitus of a hissing, rushing, ringing, or pulsating character, are usually very annoying to patients. According to Politzer,¹ this feeling of pulsation sometimes corresponds—as he was the first to prove on the intact *membrana tympani*—with a visible pulsating motion of the membrane, on which either single spots of light or a considerable portion of the bulging membrane (*Roosa*) show motions synchronous with the contractions of the heart.

Tinnitus aurium and deafness are undoubtedly due to the intense hyperæmia of the middle ear and *membrana tympani* and the inflammatory exudation, which interfere with the action of the transmitting mechanism. It is also probable that the labyrinth is simultaneously involved in some cases, as Politzer has proved the existence of an anastomosis in the blood-vessels of the middle and internal ears.

Autophony, or a muffled sound of one's own voice, is a frequent source of annoyance to the patient, who usually compares it to the hollow sound heard when talking with the head in a barrel. According to Burnett,² this phenomenon is due to the obstruction offered by the swollen aural tissues to the ready egress of vocal sounds from the ear, which in a state of health permits a normal and hence unconscious transmission of sounds both to and from it. Disease of the middle ear especially interferes with the ready normal transmission of the vocal sounds of the patient, and autophony is the result. Besides autophony, there is often a feeling of heaviness and numbness in the head.

Patients occasionally complain of hearing the same note double,—that is, the same sound will seem higher on one side, usually the affected side. I recently observed this phenomenon in the case of a lady of thirty-five who had suffered from an acute inflammation of the left ear. After closure of a perforation in the membrane, when testing the hearing with a tuning-fork, the pitch seemed about half a tone higher in the affected ear than in the normal one.

The disturbance in the hearing-distance is not so great during the stage of congestion as later, when exudation occurs, and the degree of deafness does not depend so much on the amount of exudation as on its position in the middle ear. In an autopsy of a patient of forty years, who died of phthisis pulmonalis, who became hard of hearing only during the last few weeks of life, and who especially complained of pain and violent rustling in the left ear, in which hearing-distance for speech hardly amounted to half a metre, Politzer³ found a reddish, opaque secretion in the inferior portion of the tympanic cavity and also in the mastoid cells. In the niche of the *fenestra rotunda* a tough, firmly-adherent, muco-purulent plug was

¹ Diseases of the Ear, p. 248.

² Treatise on the Ear, p. 354.

³ Diseases of the Ear, p. 249.

discovered, which could be removed only with a fine forceps after repeated attempts; the niche of the fenestra ovalis was also filled with a tough lump, so that only the capitulum of the stapes was visible. The cause of the great deafness, therefore, in this case, was clogging of the two fenestrae with tough plugs of mucus.

CASE I.—*Acute Inflammation of the Middle Ear from Sea-bathing.*—T. D., aged sixteen, June 26, said that three days ago he went in bathing, and directly afterwards experienced pain in both ears, and since then the pain has been especially bad at night; he has also been suffering from headache.

Otoscope Examination.—On removing some epithelium and cerumen from the right auditory canal, the membrana tympani is red and lustreless. The left membrana tympani also dull and congested.

CASE II.—*Acute Otitis Media from Sea-bathing.*—R., aged twenty-five, July 18, consulted me and said that a week ago Sunday he went in bathing, and the following day the left ear began to pain him. Tuesday there was a slight discharge, with some blood; he dropped some laudanum and sweet oil into the ear. The pain lasted till Wednesday morning; since then he has been annoyed by tinnitus, and the ear feels stuffed up. There is some autophony. He hears ordinary voice with the left ear.

Otoscope Examination.—Left membrana tympani congested at the upper portion and slightly below; a small clot of blood on the drum-head, situated just below the umbo.

CASE III.—*Acute Otitis Media, with a Purulent Discharge, followed by Mastoiditis Interna.*—E. Mc., aged ten, August 18, says that six days ago he went in bathing, and on the following day began to complain of pain in the left ear, which has lately become very severe; two days ago he had chilly sensations, and he has been sick and feverish. There is no discharge.

Otoscope Examination.—No pus in the left auditory canal; left membrana tympani red, lustreless, and humid, especially around Shrapnell's membrane.

August 21.—Patient much worse; the pain very severe, especially at night, and it has not been relieved by a purulent discharge which commenced two days ago. There is marked mastoid pain, especially at night, the mastoid at apex being markedly tender on pressure. The patient looks very anæmic and weak, and before each onset of pain he has chilly sensations followed by fever; he does not suffer, however, from headache or nausea; temperature 101° F. at 5 P.M.

August 22.—Pain very much better and apparently very much relieved by leeching. He was also given tincture of aconite, one minim, and compound tincture of ipecac, two minims, every two hours; his bowels were also opened by a saline cathartic. The discharge from the ear is slight and the mastoid pain much better. The membrana tympani is less congested. Politzer inflation gently used and iodoform insufflated in ear.

August 29.—No pain now. He has been steadily improving. Dis-

charge slight from ear. He complains of a buzzing tinnitus. Hearing-distance, watch, $\frac{6}{48}$. No discharge seen, on examination, in the external meatus. The membrana tympani is still red and covered with dry crusts. He was given a tonic containing potassium iodide, syrup of iodide of iron, and compound syrup of hypophosphites.

September 28.—No trouble with the ear now, except an occasional tinnitus. Hearing-distance, watch, $\frac{18}{48}$. The membrana tympani desquamating, but still somewhat reddened and slightly retracted. Politzer inflation.

It will be seen from these cases that cold-water bathing may be the cause of an inflammation of the auditory canal or membrana tympani, or that an acute otitis media catarrhalis or purulenta may follow and in some instances be complicated by mastoid disease.

The following cases show the ill effects, at times, of the advice given by some practitioners to “sniff up” salt-and-water, etc., for nasal catarrh.

CASE IV.—*Acute Otitis Media due to “sniffing up” Water through the Nose.*—John A., aged forty-three, German, came to the New York Eye and Ear Infirmary, August 11, 1884, and stated that for a long time he had been in the habit of “sniffing up” water in the nose, and five days ago, after doing so, he felt a pain in the left ear as if something had broken. Since then the pain has continued, and is especially severe at night. There is also marked tinnitus in the left ear.

Otoscopic Examination.—Left membrana tympani very much congested and landmarks obscured. Right membrana tympani somewhat hazy in appearance. Hearing-distance: right ear, five inches; left ear, 0. Tuning-fork, when vibrating and placed on vertex, heard better in the left ear.

The following case is given in this connection, although properly a case of acute purulent otitis media and mastoiditis interna, on account of its having been caused by “sniffing up” glycerin for the relief of nasal catarrh.

John D., aged twenty-five, a clerk, consulted me in the latter part of April, 1885. He says he has never had ear-trouble before. He frequently has a “cold in the head.” He is a dyspeptic and not very robust in health. Ten years ago he had typhoid fever and pleurisy at the same time. He has had diphtheria twice, but some years ago. The present ear-disease commenced the middle of February, and was caused by his “sniffing up” some glycerin to relieve a bad “head-cold.” On the day following, he awoke with a dull feeling below the right mastoid. The ear discharged the next day, and he had pain for several days. The discharge at first contained mostly mucus, but afterwards pus. He consulted two physicians, and was treated by them for two months, the treatment consisting in douching the ear with warm water and the application of nitrate of silver. He derived no benefit, however, the pain and discharge continuing. When he came to me, an examination showed that he had hypertrophic nasal catarrh, with the septum deviating to the right side, so that the passage was very much contracted. Left membrana tympani dull, lustreless in

appearance, somewhat sodden, and it does not move when the air is exhausted by Siegle's otoscope. No cone of light. The right membrana tympani considerably destroyed and the external meatus narrowed. The posterior bony auditory wall congested and sensitive when touched with a probe. A hard polypoid mass above and coming apparently from the antrum. Hearing-distance, acoumeter: right ear, one-half inch; left ear, four inches. He hears only loud voice. Tuning-fork, vibrating and placed on the vertex cranii, heard a little louder in the right ear. The bony conduction is better than the aerial for both ears. The discharge from the right ear darkish brown and offensive. The polypoid mass was cauterized several times and the ear treated by the insufflation of different powders, with some improvement, as the discharge became less and the hearing-distance for both ears was increased by means of Politzer inflation. The improvement was but temporary, however, as the right auditory canal became narrower and more painful in the posterior bony portion. He had pains at night referred to the right mastoid, and there was a very tender spot on pressure just behind the auricle and near the antrum. The symptoms all pointed to carious bone in the mastoid, so that I decided at once to perforate the bone.

June 2.—Ether given. I perforated the bone with Buck's drills, just behind the external meatus, and found pus and granular debris, which I scraped away, and I passed a director well up into the antrum. The wound was washed with a bichloride solution and dressed with iodoform, and a tent inserted to keep the wound open. The patient was kept in bed for several days, suffering but slight discomfort, and with little, if any, elevation of temperature.

June 7.—He hears very much better since yesterday afternoon, when the discharge first came from the opening in the mastoid. No discharge now from the external meatus. No pain. Same treatment continued. Eustachian catheter used in the left ear.

July 7.—The patient was allowed to leave the infirmary soon after the operation, and has been treated as an out-patient. He has had some cold in his head, and the discharge from the ear is increased in quantity. The canal is well dilated now, the perforation is closing gradually, and the polypus has disappeared. The sinus behind the ear is gradually closing also. He has been taking pil. ferri et quininæ cit., āā gr. ij, three times daily. The ear was treated by the insufflation of powders.

October 22.—The discharge from the ear ceased about August 20. There was a gradual improvement in the patient's condition, and the sinus closed some time before the ear stopped discharging. Acoumeter: right ear, five and a half inches; left ear, two inches. He hears ordinary conversation much better than ever before. No perforation in the drum-head, which is somewhat congested about Shrapnell's membrane and opaque below. There is some tinnitus, but otherwise he is well.

CASE V.—*A Case of Acute Catarrhal Otitis Media in which the Mucus*

was of a Tough and Stringy Character.—John M., aged twenty-one, a clerk, came to me December 18, 1883, and gave the following history. He had never had much trouble before this with his ears. He got a fly into the right ear about four years ago, and he had some pain at the time. Two years later the same ear “gathered” again and there was some discharge. For the past three weeks the right ear has been discharging, and it was preceded by an earache lasting six days. There has been a humming noise in the ear since the appearance of the discharge. When examined, the right auditory canal was filled with a stringy mucus and some pus. The mucus could be pulled out in long strings with forceps.

There was also a polypus lying against the membrana tympani in the upper portion of the canal; a perforation was found in the drum-head, and the bony canal was congested. Left membrana tympani non-translucent; cone of light small, and short process prominent. Hearing-distance, watch: right ear, two inches; left ear, normal. Tuning-fork, vibrating and placed on vertex cranii, heard better in the right ear. The polypus was removed with the snare, and it was found attached to the upper part of the meatus, close to the drum-head.

April 3.—The patient has been under constant treatment ever since, improving at times, but he has taken another cold and the discharge has never ceased. The ear has been treated by the dry method, the insufflation of different powders, and Politzer’s inflation, in order to force out through the perforation all the mucus in the middle ear. He has had some symptoms of mastoid inflammation, but they have all disappeared under treatment. When examined to-day, the right membrane shows some signs of hyperæmia, but is steadily clearing up.

It is most important in these cases, when the mucus is abundant and so tenacious and stringy, to devote the greatest attention to the condition of the naso-pharynx and nasal passages, for it will generally be found that the disease proceeds from an affection of these parts. In my opinion, all treatment of the ear alone is practically useless.

CASE VI.—*Acute Catarrhal Otitis Media: Paracentesis.*—Thomas B., aged thirty-four, a native of the United States, oysterman, came to the infirmary March 28, 1882. He is subject to catarrh. He does not drink to excess, he says. Last Saturday the left ear began to pain him very severely, due probably to a cold. He has never had any ear-disease before the present attack. At present the ear does not ache, but there is a feeling of fulness about it. An examination showed a severe congestion of the left membrana tympani. It had a fleshy appearance and was bulging.

March 31.—In spite of the treatment, he has had continuous pain in the ear ever since. The drum-head is still bulging, but less hyperæmic. Punctured in the lower segment with a paracentesis-needle, and this gave vent to some bloody matter. This, together with Politzer inflation, gave great relief to the patient, who did not return again to the infirmary.

CASE VII.—*Acute Catarrhal Otitis Media: Paracentesis.*—Mary G.,

aged twenty-five, domestic, seen April 5, 1887. Last week she had a severe "cold in the head." She has had no previous ear-trouble. Last Sunday night (two days ago) she had pain in the right ear. The pain has persisted ever since, but was somewhat better last night and to-day. Hearing-distance, watch: right ear, 0 inches; left ear, fifteen inches. Tuning-fork on vertex cranii heard better in the right ear. Right membrana tympani decidedly hyperæmic; slightly bulging. The inner end of the auditory canal is likewise congested and desquamating. Right membrana tympani punctured with a paracentesis-needle and a little muco-pus evacuated. My scarificator was then used in front of the tragus and a cupping-glass applied. She was seen three days later and reported that the pain had been much less severe ever since. The drum-head was less congested. There was some pus in the meatus, which was syringed out and the patient told to apply drops of a watery solution of zinc sulphate, gr. ij-fʒi.

CASE VIII.—*Acute Catarrhal Otitis Media: Paracentesis*.—John T., aged forty-eight, November 4, 1884. He is a subject of naso-pharyngeal catarrh, and since last spring he has had trouble with his ear, which has consisted in a buzzing and whistling tinnitus in both ears, vertigo, and deafness. For about two months the tinnitus (compared to pumping of steam) has continued, which is confined to the right ear and is much aggravated on lying down. For nearly a week he has had pain behind the right ear, and this occasionally is quite severe.

November 7.—Condition the same. Right membrana tympani congested and bulging, especially in the posterior half. Paracentesis with the needle followed by discharge of some bloody mucus. Hearing-distance: right ear (after puncture), acoumeter, one-half inch; left ear, one-half inch. Tuning-fork on vertex heard better with the right ear. Still troubled with a roaring noise. Cocaine solution (four per cent.) instilled into the ear. This diminished the tinnitus.

November 14.—Tinnitus somewhat better. Right membrana tympani less congested and bulging. Cocaine instilled and the drum-head punctured again in the posterior superior quadrant. Politzer inflation forced out bloody mucus. Noises diminished by the puncturing.

November 21.—The noises are much less annoying. Still some bulging of the right membrana tympani. Paracentesis again performed, with the similar result of giving exit to some bloody mucus.

December 9.—A week after the last visit the membrane was again punctured, but no mucus escaped. He developed at the time some symptoms of mastoid disease, but these have disappeared. There is less tinnitus, and less congestion about the drum-head. The hearing-distance remains about the same.

In acute catarrhal otitis media in children the pain is especially apt to come on during the night, while during the day there may be no earache. Some children are subject to frequent attacks, and parents too often neglect to do anything, thinking that it is nothing but an earache, which will pass

away without the need of seeking professional advice. In such instances the usual treatment consists in the insertion of a hot onion in the meatus, or the instillation of some drops in the ear. These very patients, later in life, finally come to the otologist complaining of deafness which they have noticed for several months past and which they thought of no account at first, but are finally obliged to seek advice. In others, tinnitus has come on suddenly, giving them much annoyance.

Had these patients during early life received proper treatment at the time, there would be far fewer cases of incurable forms of chronic middle-ear catarrh. It is to be hoped that in the near future the general practitioner will include in his armamentarium an otoscope and an ear-speculum at least, and be able to diagnose the simple forms of ear-disease, and also that our medical colleges will require that a candidate for graduation shall have some knowledge of one of the most important organs of the human body. These frequently-recurring acute or subacute attacks during childhood lead often to adhesions and permanent retraction of the drum-head, and in some cases the internal ear is secondarily involved. Acute catarrhal otitis media in children will be found to be due in a great number of cases, especially in those who are poorly nourished or debilitated, to the presence of adenoids in the post-nasal cavity.

Too much stress cannot be laid on the great importance of making an examination of the naso-pharynx in all cases of ear-disease, and particularly in children. It will be found almost impossible to obtain a satisfactory view of this region in young subjects by means of the rhinoscopic mirror, so that the otologist will be compelled to make a digital examination. With the protection of a rubber band around the index finger to prevent the patient from biting the examiner's fingers, a diagnosis can very quickly be made in this way. In some cases the physician can take advantage of this opportunity to scrape away, particularly if he have a long finger-nail, some of these growths, or at least break them up and accomplish something at this time. Since I have been looking for these growths among aural patients, I have been impressed with the great number that I have found.

According to Meyer,¹ who was one of the first, if not the first, to call attention to the effect of these growths on the ear, he found that about seventy-four per cent. of his cases of adenoid vegetations were troubled with deafness. In his paper he calls attention to the fact that the mucous membrane of the middle ear is continuous with that of the naso-pharynx and Eustachian tube, so that it is easy to understand how the organ of hearing can participate in the naso-pharyngeal inflammation. These vegetations are generally of a bright-red color, due to their vascular character. They vary as to size from that of a small pea to that of a cherry-pit or hazel-nut. They are sometimes arranged in rows like the teeth of a comb, and form a sort of veil across the space, or they may exist

¹ Archiv für Ohrenheilkunde, 1873.

separately, and are follicular in appearance. They are usually of a soft consistency, and may present a smooth surface or an irregular one. There are as a rule several vegetations, although they have been found singly. The presence of these tumors may set up an inflammation extending through the Eustachian tubes, or, growing in a favorable position, they may press upon the orifice of the Eustachian tube and in this way cause deafness by interfering with the proper ventilation of the middle ear.

A microscopic examination of these growths, according to Meyer, showed that they are composed of a net-work of connective tissue supporting countless lymph-corpuseles or lymphoid cells as they are sometimes called. Here and there throughout the section the outlet-ducts of acinous glands were also encountered. The peculiar expression of the face is very characteristic of this disease, as well as the pronunciation of certain words, the patient speaking, as it were, "through the nose." Thus, the resonance of the voice is imperfect. The patients have difficulty in pronouncing sounds of *m*, *n*, and *ng*. They also complain of frontal headache, and of a sense of fulness in the naso-pharynx, and the sense of smell is impaired. Meyer has noticed a frequent escape of blood from the naso-pharynx into the mouth in about fifteen per cent. of all his cases, and he says of the breathing that it takes place exclusively by the mouth. There is also a lack of tone in the play of the features, and the expression is characterized by a certain shade of sadness. After the breathing has taken place for a certain period of time exclusively through the mouth, the nose assumes a peculiar sharpness of outline; it looks pinched and the alæ appear to be sunken. Two thousand school-children of both sexes were examined by Meyer in the public schools of Copenhagen by simply looking at their faces and hearing them speak. Of these, he found twenty children in whom these characteristics were well marked. In England he found the number to be thirteen out of seven hundred. In some cases the tendency to this disease seems to be hereditary. These growths are most frequently found between the ages of three and fifteen or twenty. It must be borne in mind that, although this subject of adenoids is a most important one to the otologist, in a certain number of cases there is no hardness of hearing, as shown by the different tests. These tumors, however, should be removed in all instances wherever practicable, in order to prevent the disagreeable nasal tone of the voice and to allow the patient to breathe properly through the nose. In many instances I have known the general health to improve very markedly after the removal of adenoids.

The subject has been discussed by Czermak, Türk, Voltolini, and more recently by Hooper, of Boston. For the removal of these growths Meyer recommends an annular knife one centimetre in diameter, the sharp edge of which is formed by the inner margin of the circle. The instrument is twenty-one centimetres in length. Politzer¹ describes the manipulation of

¹ Diseases of the Ear, p. 320.

the instrument as follows. The instrument, held in the right hand, is inserted between the septum and the spongy bones as far as the posterior pharynx, with the knife perpendicular, and is then turned so that the position of the knife becomes horizontal. The left forefinger is now introduced through the mouth and behind the soft palate towards the superior wall of the pharynx, until the instrument is felt with the point of the finger. The knife is pressed with the tip of the finger against the excrescences, which can be felt on the roof of the pharynx; they are thus forced inside the ring. The instrument is now drawn outward, and the vegetations surrounded by the circular knife are cut off, and are discharged from the mouth and nose by a strong act of expiration. Meyer also recommended a second method,—viz., cauterization with solid nitrate of silver. For this purpose Politzer¹ uses an instrument consisting of a quadrilateral piece of silver one and a half centimetres long and four millimetres in diameter, which is furnished with a handle twenty centimetres long. The four sides as well as the free end of the prism are roughened like a file, in order to give the nitrate of silver, which is melted upon it, a firmer hold. Now, if the posterior, the lateral, or the superior wall of the pharynx is to be cauterized, the nitrate of silver is melted only upon the corresponding surface of the instrument, the anterior extremity of which can be curved as required. It is introduced behind the soft palate into the superior pharynx after depressing the tongue well, and the growths are thoroughly cauterized by passing the instrument backward and forward over them several times. Politzer does not repeat this cauterization till after an interval of one day. To relieve the burning sensation he pours a solution of warm salt-and-water through the nares into the naso-pharynx. The number of such cauterizations varies from four to fifteen, and they must be repeated until no trace of such growths can any longer be detected by digital examination.

It is believed by some writers that these vegetations, if left to themselves, will eventually shrivel up after adult life, but this course of procedure is not advisable, as permanent changes in the organ of hearing are apt to take place and the tone of the voice become very disagreeable and unnatural, and the patient's health is liable to suffer. Hooper² describes his method of operating as follows. He operated on one hundred and four children of ages ranging from twenty months to fourteen years.

The child is thoroughly etherized, placed in a good light, and seated upright in the lap of an assistant, the operator being seated opposite. The child's mouth is held open by a small-sized mouth-gag inserted between the teeth on the right side. Any accumulation of mucus in the pharynx is to be wiped out. The operator should now pass his index finger up behind the soft palate and assure himself of the quantity and situation of these growths. Then, gently pulling the soft palate forward and upward by

¹ Diseases of the Ear, p. 321.

² Boston Medical and Surgical Journal, March 15, 1888.

means of a palate-hook held in the left hand, a pair of post-nasal forceps, held in the right hand, is introduced, closed, into the naso-pharyngeal cavity. One soon learns to feel the growths with the closed end of the forceps. The blades are then opened, and the mass grasped and pulled off either by direct traction or by a slight twisting movement of the forceps, but under no circumstances is force to be exerted. If the growth comes away with difficulty, release the blades of the forceps and begin over again, taking hold of a smaller portion of the growth. The finger is to be inserted in the cavity from time to time until it is found that the naso-pharynx is practically free. After this is done, Hooper holds the child's head well forward, so that the blood may flow out of the nose, and with the finger-nail of the left hand he smooths down the remaining ragged edges in the different parts of the naso-pharynx. He finds it necessary in some cases to use other instruments,—a post-nasal curette, or the steel finger-nail of Sir William Dalby, or Meyer's ring-knife,—but, as a rule, he says, "the happiest results may be accomplished with the forceps and the forefinger alone. With proper care and assistance there is no danger for the child, and in one sitting, occupying from ten to twenty minutes, it is practically cured of a complaint which may have existed for years." "The removal of the growths, however, is not accomplished in all cases with equal satisfaction. The conditions which make the operation difficult are an excessive amount of mucus in the throat, a large thick tongue, enlarged faucial tonsils, a long distance from the lips to the postpharyngeal wall, a small space between the free border of the palatal curtain and the pharynx, and a deep naso-pharyngeal cavity."

Adenoid growths, although found most frequently in children, are, however, also observed at times in adults. Such patients are subject to attacks of catarrh and impairment of hearing. One of the most interesting clinical facts is that the amount of hypertrophy of Luschka's tonsil is at times out of all proportion to the impairment of hearing, the hypertrophy being very slight in some instances of very defective hearing, while in other cases of considerable hypertrophy there may be but slight deafness. In a paper published in the *New York Medical Journal*,¹ Delavan describes a unique case of temporary enlargement of the tissue at the vault of the pharynx. A young lady of eighteen, blonde, somewhat delicate, but on the whole well developed and in the enjoyment of fair health, was treated by an eminent American otologist during one winter, with tolerably good results. In the following summer she went abroad. While in London she consulted Sir William Dalby, who, on making a digital exploration of the upper pharynx, stated that he found there a considerable mass of adenoid growths which, in his opinion, should have been long ago recognized and removed. Sojourning in Paris, the patient was placed under the care of one of the best specialists in Europe, who made a rhinoscopic examination and failed

¹ October 12, 1889.

entirely to confirm the diagnosis of the London physician. In the fall she returned to New York and again visited her American physician. He, having heard the testimony from abroad, re-examined the vault of the pharynx and found an abundant hypertrophy. He admitted his failure to find it at former examinations, said that the criticisms of the gentleman in London were merited, and sent the patient to me for operation. In the course of time she appeared. Careful rhinoscopic examination of a pharynx remarkably easy of demonstration revealed absolutely nothing except a decided redness and a very slight degree of thickening at the pharyngeal vault. By this series of successive contradictions, the parties concerned were much discomfited. Further investigation revealed the fact that the patient had contracted a severe coryza both on the outward and on the homeward voyage, and that she was suffering from these colds when examined in London and afterwards in New York. Examined before her departure, again in Paris, and finally in New York after the subsidence of the acute symptoms, no appreciable enlargement was present. The hypertrophy, therefore, was due to these acute attacks; it existed during their course, and when they subsided it disappeared. This phase of adenoid disease does not seem to have been described. Certainly it is so little understood as, in the present instance, to have misled three of the most eminent specialists living. It appears to be analogous to the acute enlargement of the tonsils commonly seen in patients in whom these glands are irritable and liable to swell during attacks of cold. It is a condition capable of causing much annoyance. Perhaps the best descriptive title which could be applied to it is acute recurrent enlargement of the adenoid tissue at the vault of the pharynx.

I believe it highly important to remove in all cases every trace of the adenoid tissue, and the patient should not be pronounced cured until this has been accomplished. Although adenoid tissue is occasionally found in children in good health, it is more frequently observed among those who are scrofulous or otherwise debilitated. Delavan says in regard to this point that "not uncommonly the subjects of this disease are the children of tuberculous parents. Indeed, the frequency with which it is found associated with a tuberculous history is somewhat remarkable. Hereditary syphilis, too, is responsible for many cases, some of the worst which have come under the observation of the writer having been in children of syphilitic parents. This, of course, is no more than would be expected, as the hypertrophy of the pharyngeal adenoid tissue is but another expression of the general strumous condition under which such patients labor."

Blake¹ has written a most valuable paper on this subject of adenoids, in which he says, "The train of aural symptoms which come from the presence of adenoids are, therefore, such as would result from interference

¹ Boston Medical and Surgical Journal, March 15, 1888.

with the normal ventilation and nutrition of the middle-ear tract, and are more or less permanent according to the duration and size of the adenoid growths.

"In the earlier stages, when the growth is small, the ear is noticeably affected only when, in addition to the bulk of the growth in the nasopharynx, there is added the encroachment upon the space of that cavity by swelling of the mucous membrane accompanying so-called head-colds. As the growth increases, less and less swelling effects the deleterious purpose, and the intervals of freedom from impaired hearing, nocturnal earache, and subjective noises in the ears become shorter and more rare.

"In the mean time changes are taking place in the structures of the middle ear which are more or less permanent; the preponderating pressure on the outer surface of the membrana tympani pressing that membrane inward and allowing the relaxed tendon of the musculus tensor tympani to contract and hold the malleus, and with it the membrana tympani, in its abnormal position, tends, as does also the thickening of the mucous membrane, to permanently impair the mobility of the sound-transmitting mechanism of the middle ear, or, as is seen in some cases, the impairment of nutrition lowering the vitality of the delicate tissues in the middle ear, an ulcerative and suppurative process is easily set up under the necessary additional provocation."

Blake concludes his paper by saying, "It is well to bear in mind, however, that with the removal of the adenoid growths the work as regards the ear is not entirely done, and that the rhinologist and otologist must act as friends in council. The removal of the cause is the first step, it is true; but though, as Dr. Holmes says, 'nature is kinder than the doctors think,' some assistance is needed in many of these cases to help on the removal of the consequence of the cause."

The results in Blake's cases, operated on by Hooper, show that, out of the whole number, thirty-nine, or nearly eighty-three per cent., gave evidence of more or less implication of the ear, and that of that number, in thirty-five, or nearly ninety per cent., the result, as evidenced by the improvement in hearing, was eminently satisfactory. For further information in regard to this most interesting subject the reader is referred to the article on adenoids in this work.

In regard to the operation, I always have the patient, if a child, etherized and placed in the recumbent position with head turned to one side. The choice of forceps depends very much on the one the operator is in the habit of using. Hooper's forceps will be found of great service in some cases, while in others Loewenberg's or Dalby's steel finger-nail will be preferable, according to the size, shape, and position of these growths. Meyer's ring-curette or Gottstein's or Politzer's instruments are also useful. The base of the growth should be cauterized from time to time, after the operation, with nitrate of silver or with chromic acid if any part of the growth remain. After the operation the patient should be kept quiet in

bed for a day or two, and, if anæmic or scrofulous, should be given full doses of iron, quinine, cod-liver oil, etc.

Some surgeons prefer Gradle's forceps for removing these growths. I have not, as yet, used them, but from what I have seen of them in the hands of others, they certainly deserve all the praise they have received.

Appearances of the Membrana Tympani.—In mild cases of acute catarrhal otitis media there may be but slight hyperæmia of the drum-head, especially marked about the short process and along the handle. There may or may not be congestion of the bony auditory canal. In other more severe cases, there is well-marked injection of the vessels, and the whole membrane may be of an angry-looking, livid color. The dermic layer, being infiltrated, gives the membrane a dirty-grayish appearance, and the only landmark may be the short process, which stands out as a red or yellowish-white point. Frequently there is a bulging of the membrane of a bluish-red color in the posterior superior quadrant, due to inflammatory infiltration. In other cases there are occasionally observed one or more vesicles and interlamellar abscesses.

Politzer¹ describes, among the rarer occurrences in acute otitis media, bulgings and exudation-sacs on the membrana tympani and communicating with the middle ear. They are usually situated on the posterior superior portion of the membrana tympani, and he says "they are distinguished from the blisters occurring in acute myringitis or from the blister-shaped, pale-yellow swellings (Schwartz) containing serous and transparent mucous exudations, observed in recent catarrhs, by their being not tense like them, but loosely bag-shaped; also by their being not transparent, but of a greenish or yellowish-gray color, according to the fluid they contain, whether purulent or opaque mucus, and by the portions which are not bulged out showing great congestion, swelling, and infiltration. That these sacs are in connection with the tympanic cavity is proved by the fact that during the Valsalvan experiment, or after injecting air into the tympanic cavity, the sac bulges strongly forward and changes its form, air or exudation, or both, being forced into it from the tympanic cavity. A remarkable change of color will then be observed in the rapidly-increasing swelling; for while the superior portion appears gray and transparent, in the inferior portion of the blister or of the sac may be seen a yellowish-green exudation, which is demarcated by a sharp line from the air-filled upper portions of the swelling. In some cases there will be a bulging outward of the membrana tympani, especially in the posterior inferior quadrant or about Shrapnell's membrane, due to the presence of fluid in the tympanum. When the hyperæmia of the membrana tympani begins to disappear, those portions of the drum-head between the malleus and periphery will first begin to clear up (see Plate I., Fig. G), when, instead of a livid red color, the membrane will gradually assume a dull gray color and there will

¹ Diseases of the Ear, p. 246.

appear small, tortuous vascular branches running from the periphery towards the handle of the malleus. Frequently the epidermis peels off from the membrana tympani. This congested appearance of the membrane may continue for several weeks, and depends very much on the condition of the tympanic cavity, and especially on the amount and character of the exudation. Gradually the membrane will assume a normal appearance, the congestion remaining longest along the handle of the malleus and about Shrapnell's membrane."

The duration of the pain and inflammation varies greatly. The pain may last only a few hours or may continue for several days. There may be but a slight congestion of the membrana tympani, which will also disappear in a few days. Much depends, however, on the cause of the attack, and especially on the constitution of the patient. Patients addicted to the abuse of alcoholic drinks and those who are debilitated and subjects of catarrh will be likely to have the attack last for some time.

There may be several relapses, so to speak; that is, the pain and inflammation may return suddenly after the patient seems on the high-road to recovery. Even after the patient is pronounced cured, especially if a child, there is for some time danger of a relapse, and a return of the disease may occur at times for several years after. When acute catarrhal otitis media occurs during the exanthematous diseases, and in individuals of a tuberculous, cachectic, or serofulous temperament, the prognosis becomes much more grave. In the latter cases, the disease is more apt to run into an acute purulent inflammation, followed in some instances by the presence of polypi, and caries may ensue.

CASE I.—*Adenoids in the Naso-Pharynx.*—*Deafness.*—Alfred N., aged seven, came to the infirmary January 5, 1892. He has had a discharge from the left ear, on and off, for two years, which was probably caused by measles. He always breathes through the mouth and is restless at night.

January 18.—Under etherization, the growths were removed from the naso-pharynx.

January 26.—Breathing much improved, and he sleeps quietly. The discharge from the ear has ceased. Hearing distance, acoumeter: right ear, normal; left ear, two feet.

CASE II.—*Adenoids in the Naso-Pharynx.*—*Discharge from the Ear.*—John M., aged four and a half, January 23, 1892. Mother says he has always been weak-minded. The child says but few words and is poorly nourished. He breathes with mouth open and is very restless at night. There has been a discharge from one ear for twelve days.

January 25.—Under ether, the posterior nares were examined with the index finger and found filled with adenoids. These were removed by my assistant, Dr. Hewitt, almost entirely in one cut of the Gradle forceps. There was considerable hemorrhage, but it soon ceased.

February 5.—The child's general appearance has very much improved. He both sleeps and breathes better, and he is in brighter spirits. The

hearing is also much better, and the discharge less. The mother is very enthusiastic over the good effects of the operation. The ear has been treated with boric acid solution, and he is taking a tonic in the form of syr. ferri iodid. (minims x) three times daily.

The two following cases will show that the disease is not confined to children :

Jacob P., aged eighteen, a butcher, has had a discharge from the left ear for a month, following a cold, he thinks. He is a mouth-breather. There is a discharge in the left meatus, and the membrana tympani is perforated. On examining the naso-pharynx, there are seen masses of adenoids surrounding the Eustachian tube. These were removed, and he was given a solution of sulphate of zinc (gr. ij-aq. f 3j) to drop into his ear.

Richard P., aged twenty-eight, Irishman, says he has been deaf for the past ten years. He is troubled with vertigo at times, and he has a hissing tinnitus in the left ear. He hears the acoumeter at a distance of eleven feet with each ear. The left membrana tympani is opaque and shows catarrhal changes. He breathes through the mouth, and he has diminished sense of taste and smell. An examination of the naso-pharynx shows it to be hyperæmic and hypertrophied. He has had catarrh in the nose and throat since childhood. A mass of adenoids, on examination with the rhinoscopic mirror, was found hanging from the vault of the pharynx.

Treatment of Acute Otitis Media.—I believe the local abstraction of blood to be the most valuable method of treatment in the first stage of both acute catarrhal and acute purulent otitis media. Otologists both in this country and in Europe are generally agreed as to the great value of leeches in these cases attended with intense pain, where there are great hyperæmia and infiltration of the parts and engorgement of the vessels in the periosteum and mucous membrane. In such cases the pain is almost always alleviated and frequently is removed by the local abstraction of blood, and in many instances, I believe, the further progress of the disease is arrested.

According to Schwartze,¹ "in cases of acute middle-ear catarrh where the pain is severe, if leeches are applied, in the hyperæmic stage, close to the tragus, they will not only relieve the pain and tension in the ear, but will cut short the inflammatory process."

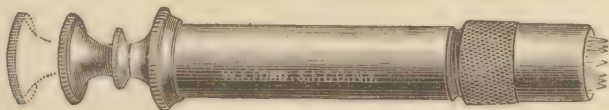
Wilde and Von Troeltsch² have shown that the blood-supply of the tympanum is influenced by the local abstraction of blood, when the point for the operation is selected close to the tragus, in front of the pinna. This is due to the fact that the veins from the membrana tympani run along the anterior superior wall of the external meatus and empty into the anterior facial vein just in front of the tragus. Politzer says that "bleeding in this locality will also effect a depletion of the venous net-work situated in

¹ Die Chirurgischen Krankheiten des Ohres, p. 135.

² Politzer, Diseases of the Ear, p. 253.

the cavity of the maxillary joint and its neighborhood, the importance of which Zuckerkandl was the first to point out; the supply of blood in the vessels of the tympanic cavity, which are in communication with those vessels, being thus lessened." There is also an anastomosis between the

FIG. 4.



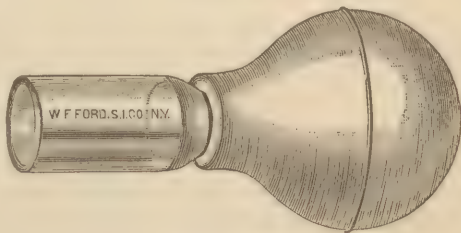
Scarificator.

vessels of the mastoid cells and the vessels of the integument covering the mastoid process, so that local bleeding at this latter point will produce a temporary depletion not only of the vessels from the mastoid, but also of those from the tympanum anastomosing with them. For a number of years I have been using an artificial leech and the instruments—a scarificator and cupping-glass—I described in the *New York Medical Journal*.¹

The scarificator (shown in Fig. 4) has seven lance-shaped needles, very similar to those of an instrument exhibited at a meeting of the New York State Medical Society by Dr. David Webster, which he uses, together with cocaine and galvanism, for producing anæsthesia about the eye, except that I have substituted different needles. The depth of the punctures can be regulated by screwing or unscrewing the end or cap of the scarificator. When this is determined, the spring is pulled back, the instrument is applied to the parts, and the tissues are scarified.

A cupping-glass (Fig. 5) similar to those manufactured by the Davidson Rubber Company, except that the glass is made smaller and adaptable to the parts about the ear, is then immersed in hot water for a few moments, in order to promote the bleeding as much as possible, and applied close to the tragus or below the lobule or over the mastoid process.

FIG. 5.



Cupping-glass.

The glass itself holds three drachms. If necessary, three cups can be applied at once in front of the tragus, just below the lobule and over the mastoid.

Heurteloup's artificial leech is recommended by some, but my objection to its use is that the cutting instrument causes considerable pain and the cupping-glass is so large that its application behind the ear is attended with much difficulty, on account of the irregular surface of the mastoid process. On the other hand, the punctures made with the instrument which I use

¹ January 7, 1888.

cause but little pain, and the cupping-glass is applied without difficulty and held in position by the patient, this method in every way being much simpler than the use of leeches. The counter-irritant effects are, according to Bartholow,¹ "much more pronounced from cups than from leeches," and Biddle² says, "cups are generally preferable in internal inflammations, from their more decided revulsive influence."

For the following reasons I have been led to substitute the wet cup for the leech :

1. Many patients, and especially children, have a great dislike to have a leech applied to the ear, so that it is extremely difficult in such cases to use them.

2. The bleeding from a leech-bite is frequently difficult to arrest, and in one case that came under my observation it was necessary to resort to the actual cautery to control the hemorrhage.

3. A leech-bite occasionally gives rise to erysipelatous inflammation and ulceration, and not infrequently produces a circumscribed abscess, even in apparently healthy individuals.

4. Leeches are not always to be had, especially in the country, and are frequently a troublesome remedy, besides being expensive.

I use the artificial leech not only in dispensary practice, but also at my office, so that I am able to note the good effects usually following the local abstraction of blood, while I am certain of having the leech applied at the proper point about the ear, which is a most important factor.

Blake recommends scarification of the drum-head in certain cases. I have had, however, no experience with this method. Poultices should be avoided in all cases, as being an obsolete form of practice.

In children, warm water poured into the meatus will frequently relieve the pain at once, and in severe cases in adults, where the artificial leech has failed, I usually advise the hot-water douche in which is dissolved boric acid (3j-Oij). For this purpose Lucae has invented a most ingenious glass double tube, which is connected by a rubber tube with the douche, and is so constructed that the stream of water passes through one part of the glass tube to the meatus and is carried off by another portion of the tube into a basin on the floor. The patient holds the glass tube in the meatus all the time, and a constant stream is thus allowed to flow into and out of the ear.

In the less severe cases, where there is but slight hyperæmia, it will frequently be only necessary to inflate the middle ear by Politzer's method or by the use of the catheter. This is especially the case with children. After the acute inflammatory symptoms have subsided, the catheter or Politzer's method should be constantly employed for the purpose of removing any accumulation of mucus or other fluid in the tympanum, to restore the drum-head to its proper position, and to break up any adhesions

¹ *Materia Medica and Therapeutics.*

² *Materia Medica*, p. 19.

or prevent their formation. If there is much constitutional disturbance, the bowels should be kept open and the action of the skin promoted. All alcoholic drinks and tobacco in every form should be avoided. In the early stage, particularly if there be any fever, aconite in small and frequently-repeated doses should be given. The patient should be kept quiet in the house and given a light diet. If any inflammation exists of the pharynx, nares, or naso-pharynx, these parts should receive proper treatment in the form of sprays. Warm and soothing gargles are highly to be recommended.

The pain in some cases will be relieved by dropping into the ear a solution containing atropinæ sulph., gr. ij, acid. boric., gr. x, and aquæ destil., f̄ 3i, or a four-per-cent. solution of cocaine hydrochlorate. These solutions should always be very warm before being dropped into the meatus. The use of quinine is to be avoided in all cases of acute inflammation of the ear. It undoubtedly aggravates the case by increasing the hyperæmia as well as the tinnitus. Patients subject to frequent "head-colds" should be cautioned against the practice, which has become so popular, of "aborting" a cold by taking large doses of quinine. In some cases where the pain is very severe it will be necessary to give an opiate, but these cases should be very rare. Catarrhal subjects who frequently take cold and are liable to attacks of earache should be advised to sponge the neck and chest with cold water every morning and to follow this up by vigorous rubbing with a coarse towel. They should also be advised to protect their feet in damp weather, and to lead as much as possible an out-of-door life. Although the sudden changes in temperature undoubtedly aggravate the catarrhal symptoms, still, the furnaces and steam-heaters in our city houses are responsible for a great deal of the trouble. If, in spite of antiphlogistic and other measures, we find bulging of the membrana tympani, with indications that a perforation is likely to occur, it should be punctured with a paracentesis-needle, as shown in Fig. 6. This instrument of Politzer's will be found an excellent one, and the handle is so arranged that other instruments can be used straight or at an angle.

FIG. 6.



Paracentesis-needle (Poltizer's).

This operation should be done only under good illumination with mirror and speculum, and the head of the patient should be held by an assistant. The point of puncture usually selected is in the posterior inferior quadrant, although it is generally advisable to incise the membrane at the most prominent point of bulging. In some cases Politzer's inflation must be used to remove the collection of fluid in the tympanum. This should be done most gently and only in those cases where the mucus does not escape easily. Politzer's¹ experience is decidedly against the hasty performance of this operation in cases of acute catarrhal otitis media, for he has "repeatedly observed in a bilateral affection that a lingering muco-purulent discharge took place from the ear which was operated on, while in the other ear, in which paracentesis was not performed, the cure and complete re-establishment of the hearing-power were effected much more speedily by inflation according to my method." "Paracentesis gives unfavorable results in scrofulous, weak patients, in whom, according to my experience, a very lingering chronic suppuration of the middle ear, with its consequences, frequently develops after the operation."

SUBACUTE CATARRHAL OTITIS MEDIA.

This form of inflammation is recognized and described by some writers on otology, but denied by others, who consider it simply a mild form of acute catarrhal otitis media. It is distinguished from the latter by the patients' having little or no pain. The attacks are apt to recur at intervals of several weeks or months, and the disease is most frequently seen in so-called catarrhal subjects,—*i.e.*, in patients who have a granular pharyngitis or a naso-pharyngeal catarrh and are hard of hearing at times. Frequently this disease is associated with enlarged faucial tonsils or adenoids, and in such cases no permanent improvement can be expected until the seat of the disease is properly treated. These cases of subacute catarrh frequently pass into the chronic stage, and should be considered as chronic cases when permanent changes have taken place in the color of the membrana tympani and adhesions have drawn inward the drum-head and in some cases ankylosis of the bones has occurred. Subacute catarrhal otitis media is characterized by a certain amount of swelling of the mucous membrane of the tympanum and Eustachian tube and of mucous secretion in these parts. The air being rarefied in the middle ear, the membrana tympani is drawn in. It may be of a pinkish color, due to slight hyperæmia, or the congested appearance of the middle ear may be the cause of it. The light spot is either smaller than usual or displaced. Tests with the watch or acoumeter show a considerable deafness, and the tuning-fork, when vibrating and placed on the vertex cranii, is generally heard better with the affected ear,—that is, the bone-conduction is better on that side. This form of catarrhal deafness is very often observed among school-children, who are

¹ Diseases of the Ear, p. 288.

considered in many instances by their parents or teachers to be either stupid or absent-minded. Tubal catarrh was formerly the diagnosis made in many of these cases, and in such the changes consisted in more or less swelling of the faucial end of the Eustachian tube, which contained some mucus. There is also apt to be retraction of the membrana tympani. These patients should be classified, however, under the head of cases of subacute catarrhal otitis media, as they are generally found to be subjects of chronic pharyngeal or naso-pharyngeal catarrh.

Sero-mucous catarrh, or *hydrops ex vacuo* (Zaufal), is another form of inflammation which should be included in a description of the disease under consideration. These cases are often of a chronic nature, and as such should be considered under chronic catarrhal otitis media; but this serous or sero-mucous exudation occurs at times during the course of an acute inflammation of the naso-pharynx and has existed as such for only a few days. In such cases there is usually a catarrhal condition of the tube, confined mostly to the faucial end, leading to closure of the same. It is supposed by some that the vacuum being produced in the tympanum leads to this serous exudation, whence the name *hydrops ex vacuo*. Besides retraction of the membrane, there may be hyperæmia of the membrana tympani, or other changes of color will be observed according to the character, color, and amount of the exudation, the transparency of the drum-head, and the condition of the tympanum. If the membrane be transparent and the exudation of a sero-mucous character, there will be observed on the drum-head a line of demarcation between that portion of the middle ear containing fluid and that containing air. The latter, as shown in Plate I., Fig. E, is usually of a dark-grayish color, and the former greenish-yellow. Politzer¹ was the first to describe this peculiar appearance of the membrane, and he says that "frequently the line of fluid is visible only in front of the handle or only behind it, or it may be that it is seen only under a certain light." When the fluid is watery, a change in position of the patient's head will cause the level of the fluid to vary, while if it is thick and contains mucus the change in the line will be very slow, if any. It is after inflation, in cases of a transparent membrane, that an interesting phenomenon is observed. Then the air-bubbles, as rings, can be seen, and they change their locality frequently just after inflation. Besides the pain complained of, which is usually but slight, another symptom in subacute catarrhal otitis media is a sense of fulness or pressure in the ear. Usually there is some tinnitus, but it is of an intermittent character, which is generally relieved by inflation of the ear, unless permanent changes have taken place in the tympanic cavity or there is associated some labyrinthine disease. Other symptoms complained of are autophony, or the hollow sound of the patient's voice, and a cracking sound in the ear, probably due to a sudden separation of the walls of the Eustachian tube. In these cases

¹ Diseases of the Ear, p. 263.

of sero-mucous catarrh there is more or less deafness, as shown by tests with the watch or the acoumeter. The tuning-fork placed on the median line of the head is generally heard better with the affected ear, unless there be some change in the labyrinth.

Prognosis.—The prognosis of subacute catarrhal otitis media when due to cold and occurring in a healthy individual and where the patient receives proper treatment is generally good. It is not so favorable in those who are debilitated, or in cachectic individuals, or in those suffering from the exanthematous diseases, etc. When the noises persist in spite of treatment and the deafness is not cured, the disease may readily become chronic, leading to the formation of adhesions, and in some cases implication of the labyrinth may result. In such cases the tuning-fork and Siegle's otoscope will aid us in making a diagnosis.

A most interesting case of serous accumulation or recurrent dropsy of the left middle ear has been reported by C. H. Burnett.¹ The patient, a man fifty-five years old, who had been treated for a catarrhal condition of the left ear before applying to Dr. Burnett, complained that there was "a drop of movable fluid" in his left ear. After paracentesis, a brownish-yellow, transparent fluid escaped when the patient inflated by Valsalva's method. This was done in September, and in the following March he returned and had a second paracentesis performed, with a similar result,—*i.e.*, escape of fluid. During a period of nine years the membrana tympani was incised thirty-eight times, and at the last report his hearing was nearly relatively normal; he has no further sensations of filling up of his ear, but he is as dizzy as ever when he turns round suddenly. The membrana tympani moves easily and plainly under Valsalva's inflation.

Burnett says, "It is worthy of note that the patient's sensations first drew attention to the fact that movable fluid was in his tympanic cavity. Bubbles were rarely seen in the course of eight years, and not at all until many operations had been performed on the membrana tympani. Valsalva's inflation was usually very easily performed, and, as there was every evidence that the fluid in the drum-cavity never escaped by the Eustachian tube into the fauces, the thought naturally suggests itself that in this man's Eustachian tube there must have been a valve-like fold of mucous membrane or a small gland or follicle extending across the calibre of the tube and acting like a valve, opening only towards the tympanum, thus permitting air to enter the cavity, but preventing the escape of fluid from it in an opposite direction towards the fauces."

A Case of Otitis Media Serosa.—Paracentesis.—The following case came to me May 27, 1884. Andrew M., aged forty-one, a cook, has had trouble with his ears, off and on, for twenty years. He has occasional attacks of earache. The present trouble dates from five days ago, when he had some pain and deafness in the left ear, with tinnitus of a pulsating character.

¹ American Journal of the Medical Sciences, January, 1884.

The pain has been severe, and he has had some fever and general malaise. He has naso-pharyngeal catarrh, and when syringing his nose has noticed that the fluid has entered the affected ear. Hearing-distance, acoumeter: right ear (after puncture), 1 inch; left ear, 20 inches.

Otoscopic Examination.—Right membrana tympani hyperæmic and bulging through almost its entire extent, with irregular prominences, apparently due to effusions between the layers of the membrane. Left membrana tympani very thin, atrophic and translucent. Congestion along the handle of the malleus. Cone of light distorted. He has bad teeth, having lost many in the lower jaw.

The right membrana tympani was punctured with a paracentesis-needle in the lower segment, just below the umbo, and a sero-purulent fluid was blown out by Politzer inflation. There was no pain, and this gave relief to the pulsating sensation, although some tinnitus remained. Treatment was directed to the naso-pharynx.

May 30.—There has been a slight discharge until this morning. The membrane is shedding its epithelial layer, and it is also peeling off from the posterior wall of the auditory canal. There is some slight moisture on the drum-head, but on Politzer inflation no perforation is visible. Powder insufflated.

June 6.—No discharge since the last visit. Noises continue. Right auditory canal still somewhat hyperæmic. The powder is dry in the canal. The ears were inflated by Politzer's method.

Treatment.—The treatment of subacute catarrh consists in appropriate treatment of the naso-pharynx, the removal of the faucial tonsils or of adenoids if present, and the restoration of the membrana tympani to its normal position by means of Politzer's inflation or the use of the catheter. The forcing of air into the middle ear serves a double purpose: it not only forces outward the drum-head, but also undoubtedly promotes absorption of the exudation and favors its escape by the Eustachian tube. It also breaks up recent adhesions. In some cases, especially those of sero-mucous catarrh, it will be necessary to perform paracentesis of the membrana tympani and force out the fluid by Politzer's method or by the employment of the catheter. Great benefit will be found in the use of a vapor of chloric ether and iodine in subacute cases, first suggested to me by Dr. Blake, of Boston. The mixture consists of chloric ether eight parts and tincture of iodine two parts. Of this about six drops are dropped into the Politzer bag and the vapor forced through the catheter into the middle ear. In small children, simply blowing air into the nose by means of a tube is generally sufficient to open the Eustachian tube, the act of crying taking the place of swallowing water, as recommended in Politzer's method of inflation.

Besides the local treatment, the general health of the patient must be taken into account. Catarrhal subjects should be given the advice already recommended in speaking of the treatment of acute catarrhal otitis media.

In some cases it will be necessary to advise a change of climate to some dry or high altitude. Tonics, cod-liver oil, and iron are of service in suitable cases. The Valsalvan method of forcing air into the middle ears is not advisable, as the patient soon falls into the habit of constantly performing that experiment, and there is danger of the membranæ tympanorum becoming too relaxed in consequence. Besides, the patient is obliged to use considerable force in many instances, and thus the exudation and hyperæmia of the middle ear may be increased. Some otologists advise their patients to use the Politzer bag themselves. This method I cannot recommend, except in a few isolated cases when we can be sure that the patient will use it only as advised.

It is generally necessary to inflate the ears by the Politzer bag, in children, in adults in whom the naso-pharynx is particularly sensitive, and also when there is much inflammation and irritation about the faucial end of the Eustachian tube. In other cases, where possible, I prefer to use the Eustachian catheter (silver or German silver), with a rounded or probe point, such as is used by Dr. Blake, of Boston. (See Fig. 7.) A double curve in the instrument is also to be recommended. The improvement in

FIG. 7.



Eustachian catheter.

hearing is frequently quite marked after inflation of the ears, even when the membrane is not restored to its normal position. This may be due to the action of the air in forcing open the tubes and displacing the exudation in the tympanic cavity.

The best rule in regard to the frequency of inflating the ears by the catheter or by Politzer's method is to inflate at first daily for several days, where there is a steady improvement in the hearing-distance, then every other day, and gradually less frequently until only once a week. We have already spoken of the operation of paracentesis in cases of a serous exudation in the tympanum. Sometimes the fluid can be removed by a method first advocated by Politzer,¹ which he describes as follows: "The head of the patient, after he has taken a little water into his mouth, is placed in a position inclined well forward and somewhat towards the opposite side, which causes the pharyngeal orifice of the Eustachian tube to point directly downward, while the ostium tympanicum tubæ is directed exactly upward. This position of the head is retained by the patient for one or two minutes, so that the secretion contained in the depressions of the tympanic cavity may flow towards the orifice of the tube. Then air is propelled after my [Poltzer's] method during an act of swallowing, to allow

¹ Diseases of the Ear, p. 283.

the secretion, now deposited above the ostium tubæ, to flow off into the naso-pharynx by opening the Eustachian tube. That this is really the case is proved not only by Zaufal's confirmatory experiments on human ears, but also by the observations made by myself in a number of cases, in which, after the application of my method during the above-described position of the head, a liquid—serous, less frequently thick, syrupy—exudation escaped from the nasal orifice. If shortly after this manipulation the membrana tympani is examined in its normal position, instead of the yellowish lustre produced by the exudation, the membrane will be found to be light gray, and in those cases in which the line of the level of exudation was visible before inflation, it has either completely disappeared or is considerably lower than before." In cases where the mucus is sticky and tenacious and not easily removed, it will be necessary to incise the drum-head. Paracentesis is to be preferred to a method recommended by Weber-Liel. This consists in the introduction of an elastic tympanic catheter through the Eustachian tube into the middle ear and the removal of the fluid by suction.

Paracentesis should be performed in the posterior inferior quadrant of the membrana tympani, as there is less danger of doing injury here to any important part, or in the most bulging portion of the drum-head, and is applicable in those cases where there is a considerable amount of sero-mucous accumulation, and also where the exudation has not been removed by inflation of the middle ear performed for several days. An incision at least two or three millimetres long should be made, and in a vertical direction. The fluid should then be forced out by inflating the ear by Politzer's method. In some cases where it is tough and stringy it will be necessary to employ suction by Siegle's otoscope, or by a syringe connected by means of rubber tubing with an olive-shaped tip, which is inserted into the meatus. It will sometimes be necessary, in order to remove the tough mucus, to inject into the middle ear a very weak solution of sodium bicarbonate, either through the external meatus or through the Eustachian catheter. The incision usually closes on the following day. It is well to have the patient remain quietly at home after the operation, keep a piece of absorbent cotton in the ear, and take light nourishment. Politzer inflation or the catheter should be employed at repeated intervals afterwards, and when the fluid accumulates again it will be necessary to perform a second operation.

Other vapors recommended as a remedy for exudative catarrh are vapor of sal ammoniac, carbonic acid gas, vapor of iodine and camphor, and steam.

In certain cases where there is an obstruction to the entrance of air through the tubes, it will be necessary to use bougies, which are introduced cautiously through the catheter. Politzer¹ uses thin violin-strings,

¹ Diseases of the Ear, p. 295.

which he soaks in a concentrated solution of nitrate of silver and allows to dry. He afterwards pushes one through the catheter as far as the isthmus tubæ and leaves it there for from five to ten minutes, with very favorable results in cases of excessive swelling of the mucous membrane of the tube where Politzerization was impossible, and during catheterism, when the air could be forced in only with great difficulty and no benefit had resulted from the use of vapors.

ACUTE PURULENT OTITIS MEDIA.

This disease is distinguished from acute catarrhal otitis media by the greater severity of the inflammatory symptoms, the presence of pus-cells in great number, and perforation of the membrana tympani. In the first stage there is usually great hyperæmia of the tympanum, with implication of the tympanic end of the Eustachian tube. It is highly probable that the lining membrane of the mastoid cells is involved in the same inflammatory process, and in some cases, at least, considerable hyperæmia of the labyrinth exists, with serous exudation. There is in this form of inflammation more swelling of the mucous membrane. The discharge varies in its character, and also in quantity, being scanty in some cases and very profuse in others. The discharge is at times of a muco-purulent nature, and then again it may be almost wholly purulent.

There are certain exceptions to these general anatomical appearances. In consumptives the discharge appears with very little hyperæmia, the tympanum being seen through the perforation of a pale reddish-yellow color, the exudation being generally watery. In the early stage, just after perforation of the drum-head has taken place, the discharge in other cases is often of a serous or sero-sanguinolent character, becoming purulent a few days later. During the epidemics of influenza which have occurred in New York from the years 1889 to 1892, I have noticed that a very characteristic symptom of acute purulent otitis media was the great severity of the first stage, as shown by the intense pain, the great hyperæmia and swelling of the mucous membrane, and the early appearance of a sero-sanguinolent discharge. This train of symptoms I have noticed in so many instances of ear-disease following the "grippe" that I have come to look upon them as being quite characteristic. In a number of cases there has been a simultaneous affection of the mastoid cells. These cases have, as a rule, been obstinate ones to treat.

According to Politzer,¹ the pathological changes extend to the lining membrane of the mastoid cells, in which purulent exudation will always be found. Acute purulent otitis media in a certain number of cases undoubtedly begins as an acute catarrhal process, which, if unchecked, soon runs into the purulent form.

Etiology.—This disease may follow from exposure to wet and cold, or

¹ Diseases of the Ear, p. 386.

PLATE II.



SECTION OF BONE SHOWING MEMBRANA TYMPANI, TYMPANUM, AND MASTOID CELLS.—1, membrana tympani; 2, aqueductus Fallopii; 3, mastoid antrum; 4, musculus tensor tympani; 5, malleus and incus; 6, mastoid cells; 7, promontory and tympanic plexus shown by horse-hairs; 8, foramen rotundum; 9, base of stapes in foramen ovale; 10, turn of the cochlea; 11, canal of carotid artery; 12, bony wall of Eustachian tube.

from extension of a naso-pharyngeal catarrh through the Eustachian tube to the middle ear. It is also developed during the exanthematous diseases, typhus and typhoid fever, bronchitis, cerebro-spinal meningitis, pneumonia, tuberculosis, and the puerperal condition. It may follow injuries to the membrana tympani from different instruments used for paracentesis or for the extraction of foreign bodies; or inflammation and suppuration may result from falls, blows on the ear, caustic applications to the meatus and membrana tympani, or sea-bathing, as mentioned in the etiology of acute catarrh of the middle ear. Other causes are the use of the nasal douche and syringe, and "sniffing up" salt-and-water through the nose. Dentition plays a very important part, and children very frequently have a discharge from the ear during this period.

The disease occurs more frequently in children than in adults, and affects both ears more often in the former. Scarletina, measles, and diphtheria play a most important part in the causation of this disease in children. It occurs more frequently in the winter and spring, and especially during sudden changes of temperature. During the past three winters in New York it has occurred as a frequent complication of influenza.

Appearance of the Membrana Tympani.—This varies according to the degree of inflammation. Before perforation has occurred, the drum-head in mild cases may be of a pinkish color, the hyperæmia first showing itself in Shrapnell's membrane and along the handle of the malleus. More often the membrane is of a livid or bluish-red color, all signs of the long handle of the malleus having disappeared (see Plate I., Fig. F), and only the short process of the malleus being left as a landmark in the form of a sharp yellowish-white point. Sometimes ecchymomes are seen, as well as vesicles on the drum-head, which are filled either with serum or with blood, and the drum-head may be of a scarlet color or yellowish-red. In severe cases there will be great congestion of the bony auditory canal, and the line of separation between the latter and the membrana tympani will be lost. The outer layer of the membrane loses its lustre, from the exudation of serum and the swelling of its tissues, so that it has a sodden appearance. Bulging of the membrane, most often seen in the posterior half, occurs, which may be due to the pressure of fluid in the tympanum or to swelling of the tissues, and in some instances to interlamellar abscesses. The epidermis in some cases becomes saturated and loosened, and by the whitish appearance of the membrane may easily deceive the physician who is not skilled in aural diseases. If these scales are carefully removed, a very congested membrane will, as a rule, be found concealed beneath them. Perforation of the membrana tympani generally occurs in the lower anterior or posterior quadrant, very seldom in Shrapnell's membrane in acute cases. The perforation is at first usually very small, and can be seen only after the pus and scales of macerated epithelium are syringed out (see Plate I., Fig. F). Then pulsation of the fluid about the perforation will be observed. It will frequently be necessary to have the patient try Valsalvan inflation in order to locate

the perforation. The discharge just after perforation may be of a serous nature and contain blood-corpuscles, or, as I have noticed in a number of cases of purulent otitis following the grippe, there may be a decidedly bloody discharge. The secretion from the tympanum may be of a purulent or muco-purulent character, in some cases the mucus predominating, while in others there will be more pus.

Symptoms.—The pain is usually most severe in this disease, and is of a sharp, stinging, lancinating character, not confined to the ear, but shooting towards the teeth, down the neck, and in the temporal, parietal, and occipital regions. It is much more severe at night than during the day. There is more or less febrile disturbance until suppuration takes place. As before mentioned, in tuberculous patients perforation may occur without pain, and in some individuals the inflammation may be ushered in without or with but little pain, but such cases are rare. In some cases, undoubtedly the secretion is carried off through the Eustachian tube without perforation of the membranes.

Zaufal,¹ of Prague, has made important studies in regard to the micro-organisms in the secretions of acute otitis media. He obtained the material by paracentesis from individuals who were otherwise healthy, but who had acute pharyngitis, rhinitis, ozæna, or bronchitis, but no pneumonia. The secretion was divided into the sero-sanguinolent, which contained the capsule bacillus of Friedländer, and the sero-purulent, which contained the pneumo-diplococcus of A. Fränkel. These were found as pure cultures, and both can cause croupous pneumonia. The microbes can pass through the Eustachian tubes into the tympanum and set up an otitis media; especially is this liable to occur when the patient has a "head-cold."

He draws the following conclusions:

1. The normal tympanic cavity of rabbits is, as a rule, not free from germs. Though few in number, they are capable of development.

2. The mechanism of the Eustachian tube is sufficient, in normal circumstances, to inhibit the passage of numerous germs into the drum-cavity; yet it is never in so perfect a condition as to inhibit entirely the passage of some germs.

3. From the entrance of the nose to the tubal openings and the drum-cavities the number of germs rapidly diminishes. While the number at the mouth may be considerable, the number in the drum-cavity is reduced to a minimum.

Zaufal mentions four forms of infection, as follows:

1. Auto-infection, in which dormant pathogenic germs begin to grow and penetrate the tissue through nutrient changes in the mucous membrane.

2. Infection by mechanical action of the Eustachian tube, by which microbes in the nasal secretions are forced into the drum-cavity in large numbers and full virulence.

¹ Prager Med. Wochenschrift, July 6, 1887, and in the same journal for 1888, 1889.

3. Infection in which the micro-organisms which have grown in the tissue of the naso-pharynx invade the mucous membrane of the drum-cavity by way of the lymphatics and blood-vessels of the submucosa and the mucous membrane of the Eustachian tube.

4. Haematogenous infection, which, however, according to Trautmann, occurs only in acute endocarditis.

Zaufal has further shown that the presence of streptococcus pyogenes in the secretion from an inflamed middle ear is of great importance in regard to prognosis, since it has been most frequently noticed in the very serious cases of middle-ear inflammation.

Netter,¹ of Paris, has made a study of bacteriology in cases of acute otitis media, and says that there are many forms of otitis, each having a separate microbe. He describes four distinct forms of acute otitis media, as follows:

1. Otitis due to the pyogenic streptococcus of Netter, Zaufal, Moos, Holst, and Dunin.

2. Otitis caused by the pneumococcus of Fränkel, also recognized by Netter, Zaufal, and others.

3. Otitis caused by the pneumo-bacillus of Friedländer and Zaufal.

4. Otitis associated with the presence of the pyogenic staphylococcus (Fränkel, Simmonds, Dunin, Rohrer, and Netter).

Netter has found the staphylococcus aureus associated with the streptococcus or the pneumococcus in four cases of acute otitis media. As the usual mode of invasion of the middle ear is from the mouth and pharynx, it is of the highest importance to watch these cavities and to obtain an antiseptis as perfect as possible, especially in cases of measles and typhoid fever.

Weichselbaum,² of Vienna, in a post-mortem examination of a woman, aged fifty-four, found acute purulent otitis media and mastoiditis, with perforation of the drum-head and acute rhinitis. The patient had purulent periostitis of the mastoid process and commencing pneumonia in the left upper lobe, acute parenchymatous nephritis of both kidneys, fatty degeneration of the heart, acute congestion of the spleen, and swelling of the liver. There was a general atheromatous condition of the arterial system, with cardiac hypertrophy. Cultures of bacteria were made from the purulent secretion of the tympanum, the mastoid process, and the nares, and from the oedematous fluid of the lungs. The author was convinced that the specimens contained the bacillus pneumoniae.

After suppuration has commenced, the pain is usually much less severe, and occasionally ceases entirely. Children are apt to suffer very much at the commencement of an attack, which is sometimes ushered in by a convulsion or severe vomiting. They put the hand to that side of the head, and in consequence brain-trouble is sometimes suspected. Tinnitus is gen-

¹ Annales des Maladies de l'Oreille, etc., October, 1888.

² Archiv für Ohrenheilkunde, vol. xxviii., April, 1889.

erally complained of, which is described as pulsating, synchronous with pulsation of fluid seen on the membrana tympani, or of a roaring, hammering, hissing character. These noises are probably due to the secretion covering or clinging to the small bones and fenestræ, or to a simultaneous hyperæmia and serous exudation in the labyrinth. Patients generally complain of a sense of fulness in the head, and occasionally of giddiness. Deafness in these cases may be slight or very well marked, according to the intensity of the inflammation, the amount and character of the secretion, and as to whether the labyrinth is simultaneously involved. In the latter case, tests with the tuning-fork will show diminished bone-conduction, while in cases where the middle ear alone is affected, bone-conduction will be better on that side,—i.e., a tuning-fork, when vibrating and placed on the vertex cranii, will be better heard on the affected side. The deafness, generally not well marked at first, becomes much more pronounced when the tympanic cavity is filled with exudation.

Course and Complications.—In some cases the membrana tympani may be perforated in a few hours, but the usual time is from two to four days after the beginning of the attack. Some patients will complain of severe pain after suppuration and perforation have occurred. In such cases the periosteum is usually involved, or pain may proceed from the mastoid. The symptoms complained of before perforation has occurred are usually less severe after the ear has begun to discharge, and children who, a few hours before, were crying with pain, suddenly fall asleep, and the fever becomes much less. The suppuration may last several days and the perforation become closed, or it may continue from ten days to three weeks, the usual length of time in ordinary cases, while in others it may continue for several weeks or months and become chronic. After the perforation has healed, there may or may not be a cicatrix. The membrana tympani gradually loses its deep-red color and becomes grayish-red; the handle of the malleus becomes apparent again (see Plate I., Fig. G), and by degrees the drum-head assumes a normal appearance, although in some instances adhesions remain behind; opacities and atrophic changes occur in the membrane, or calcareous deposits are formed. The hearing-power is in some cases not restored to the normal for some weeks or months, especially when the tympanic mucous membrane remains swollen or some secretion forms in the tympanum.

In cachectic subjects and those suffering from the exanthematous diseases, diphtheria, bronchitis, etc., the disease is apt to run a more protracted and severe course than when it occurs in those who are healthy. Especially is this the case when the external meatus is involved and the inflammation extends to the mastoid process, or when granulations form on the membrana tympani or in the middle ear.

Permanent hearing-disturbances frequently remain when the ossicula are bound down by adhesions and secondary changes have involved the labyrinth, or when great destruction of the membrana tympani has taken

place. The complications liable to occur are caries and necrosis of the tympanic walls or of the mastoid process, more frequently seen in cachectic children suffering from scarlatina or diphtheria; or pyæmia may follow an acute case, or meningitis, thrombosis of the lateral or other sinuses, or hemorrhage from the carotid artery from acute caries of the tympanic wall. The disease may continue for several months and become chronic.

Erysipelas may occur as a complication of acute suppurative otitis media, as seen in the following cases which I reported at a meeting of the New York Ophthalmological Society.¹

CASE I.—Patrick M., Irish, aged fifty-nine, was seen January 9, 1882, suffering from a suppurative otitis media which commenced on Christmas night, when the left ear first pained him. He says there was a discharge in a few hours after the beginning of the attack, and that this has continued ever since. He complains at present of tinnitus and some pain over the mastoid process. He has never had any ear-trouble before, and is a strong and healthy man in appearance. He has bad teeth. The discharge is profuse and muco-purulent in character.

January 27.—The discharge during the past week has become less, and on January 25 the antitragus became inflamed and swollen. An erysipelatous inflammation commenced to spread from that point, and yesterday, January 26, the whole auricle (left) became involved and is now twice the size of the right one. For three or four days he experienced considerable pain in the ear. The pains behind the auricle have become less; the erysipelas now extends around the auricle, over the mastoid, and in front of the pinna. There are several granulations in the canal, which is filled with muco-pus, but less in quantity than when last seen; the walls of the canal are very slightly congested, almost normal in appearance. The drum-membrane is not well made out, as a polypus in the upper portion of the membrane prevents a good view. The erysipelatous inflammation extends upward into the scalp; tissues œdematous.

January 28.—The patient had a fairly good night. Inflammation about the auricle and mastoid somewhat less; he says he had a chill last night and felt a little chilly this morning. He has some slight fever; pulse 100. The erysipelas is gradually extending over the scalp. The patient complains of being dizzy.

5 P.M.—Lower eyelids involved now, and the erysipelatous blush extends over the forehead; pupils of normal size and responsive to light.

Temperature 104.5° F.; pulse 124. The patient's mind is clear, and he has no headache. The discharge has been free all day, and to-night the drum-head is less congested; no applications made to the canal to-day.

January 29.—The patient had a good night.

Temperature 100.5° F.; pulse 93, strong and bounding.

Left eyelid œdematous still, but the redness disappearing about the face,

¹ Archives of Otology, vol. xvi. No. 2, 1887.

forehead, and ear; there is some œdema in the left infra-orbital region, also behind the auricle, which is still swollen, but in a less degree. The scalp is tender and red over its greater extent, and pits on pressure. The pains about the ear and mastoid region have almost gone; the discharge is thick, muco-purulent, but less in quantity. The membrana tympani is much less congested, and the perforation is well seen in the posterior lower quadrant; the neck is stiff and somewhat red.

8 P.M.—Temperature 102.5° F.; pulse 102; no headache; left pupil dilated, but responds to light.

January 30.—Temperature 100.5° F.; the redness has disappeared from the face and is gradually subsiding over the scalp, but has extended somewhat down the neck.

January 31.—Temperature 97.5° F.; he had a good night; erysipelas gradually subsiding; membrana tympani clearing up, and the discharge less.

February 12.—The discharge ceased about February 2, and the noises about the same time. The watch is not heard on contact, but he hears loud voice. The membrana tympani has healed; lower half slightly congested, and the epithelium is peeling off.

March 13.—Since February 12 there has been some discharge, but when examined to-day the canal was found dry; the membrana tympani is still slightly congested and lustreless, but is clearing up. The hearing-distance is almost normal.

April 13.—The hearing good; general health and appetite much improved. The drum-head is somewhat dull, and there is some congestion along the handle of the malleus and in Shrapnell's membrane.

CASE II.—A patient, German, aged twenty-two, butler in a private family, consulted me December 28, 1883, and said that a week ago the left ear began to pain him and to discharge. He had taken cold. The pain has been principally at night; discharge slight. He has always been a healthy man; he was troubled with boils on his arms and legs a few years ago, which the attending doctor told him were due to poor blood. When very small he had some trouble with the same ear that is affected now. Last night he was dizzy and nauseated and slept but little. Hearing-distance, watch: right ear, normal; left ear, $\frac{9}{16}$. A tuning-fork, when placed on the vertex cranii, is heard louder with the left ear.

Otoscopic Examination.—Right membrana tympani lustreless, retracted; cone of light very small; short process prominent. Left canal almost occluded by a furuncle situated anteriorly in the cartilaginous portion of the meatus. Membrana tympani covered by sero-purulent fluid, and pulsation in the lower part; inner end of the canal slightly inflamed. Posterior cervical gland enlarged and hard, and there is some induration of the tissues in the ante-auricular region. The furuncle was opened and some pus evacuated. Temperature $102\frac{1}{2}^{\circ}$ F.; pulse 100.

December 29.—Temperature $102\frac{3}{8}^{\circ}$ F.; pulse 100. He slept better last night than for some time past. The induration in front of the auricle

is to-day more pronounced, and a gland at the angle of the jaw is indurated. Left ear, $\frac{2}{6}$. There is a perforation in the posterior and lower part of the drum-head; the discharge watery, but not profuse; no pain in the mastoid; there are, however, an erysipelatous blush over the cheek and indurated tissues in front of the auricle.

8 P.M.—Temperature $103\frac{1}{3}^{\circ}$ F.; pulse 105. The patient got up, and was around for several hours, but felt dizzy on walking; there is no pain in the ear, only in the indurated tissues.

December 30, 9.30 A.M.—He slept more during the past night, and feels better to-day. The erysipelas is beginning to spread, and besides involving the entire auricle, which is very much swollen, extends over the cheek and above and behind the ear. Temperature $102\frac{1}{5}^{\circ}$ F.; pulse 102. The membrana tympani is less congested, and looks better; the discharge is a little more profuse, and thicker; the posterior inferior quadrant of the drum-head is destroyed. 7.30 P.M., temperature $104\frac{3}{8}^{\circ}$ F.; pulse 100.

December 31, 9.30 A.M.—Temperature $103\frac{3}{8}^{\circ}$ F.; pulse 100. The erysipelas is fading where it commenced, but is spreading towards the nose and on to the left side of the forehead; there is none, however, below the angle of the jaw; the inflammation has extended across the nose; the left auditory meatus is closed. 2 P.M., temperature $104\frac{3}{8}^{\circ}$ F.; pulse 104. 8 P.M., temperature $102\frac{4}{5}^{\circ}$ F.; pulse 100. No delirium, no headache. The erysipelatous tissues are covered with vesicles.

January 1, 9.30 A.M.—The patient slept but little during the night, and was restless; discharge from the ear very slight; the erysipelas has involved the left eye and has now spread to the right one. 10 P.M., temperature $103\frac{2}{5}^{\circ}$ F.; pulse 100.

January 2.—He had two attacks of epistaxis since last evening. Right eye closed; left one commencing to open; the erysipelas has spread over the right cheek and has extended into the scalp. Temperature 104° F.; pulse 90.

January 3.—Temperature $102\frac{2}{5}^{\circ}$ F.; pulse 96. He had a good night, and seems better to-day; redness fading and desquamation commencing; there are some tenderness and cedema on both sides of the head.

January 4.—Temperature 100° F.; pulse 78. The perforation is closing; some muco-purulent discharge in the canal. Right auricle swollen, and tissues over the mastoid invaded; both eyes have opened, and face and forehead desquamating; the left auricle has regained its natural size; watch, left ear, one inch.

January 5.—Temperature $98\frac{1}{2}^{\circ}$ F.; pulse 85 at noon.

January 6, 4.30 P.M.—He slept well last night, and his appetite is improving. The soreness about the scalp is less. Urine examined; albuminous and diminished in quantity.

January 9.—The perforation in the membrana tympani closing; there are no noises in the ear, nor have there been any at any time; urine free from albumen.

January 14.—The patient is about his work now, and the perforation is almost closed.

In the discussion which followed the report of these cases, Dr. Roosa mentioned two cases, which are given at length in his Treatise on the Ear, in which erysipelas occurred as a complication of mastoid disease.

Dr. J. S. Prout spoke of a patient whom he had seen, Miss A. V. I., aged forty, January 17, 1879. She had acute otitis media dextra following a cold and sore throat; membrana tympani injected and pushed out. It was punctured, giving exit to bloody, serous fluid. Later on the same day two leeches were applied, with relief of pain. January 19 there was much pain, free discharge from the tympanic cavity; walls of the meatus inflamed, and they were incised up and down. There was a swelling in front of the tragus, which was punctured, but no pus escaped; the walls of the external meatus, being still inflamed, were incised in three or four places under partial influence of chloroform.

January 21.—Erysipelas set in, extending across the face, later over the scalp, reaching the neighborhood of the left ear on the 24th. During this time a free discharge persisted from the right ear.

February 2.—Her condition in general, and as to the right ear, had decidedly improved, but the left ear then became painful, and the membrana tympani red and pushed out by fluid; the drum-head was incised, giving exit to a small quantity of bloody fluid. In a week the perforation in this ear was healed. The right ear continued to discharge for a few weeks longer, with a round perforation in the lower posterior quadrant. In April furuncles formed in this ear, but they were not incised.

April, 1887.—The perforation still persists, but the ears have given no further trouble.

According to some writers, erysipelas affecting the auricle may occur as a primary or an idiopathic disease from cold and other causes, but more frequently it is due to an extension of the inflammation from parts adjacent to it. Leech-bites sometimes cause erysipelatous inflammations, as do also incisions made in the walls of the external auditory canal, in persons whose general health is not good. When the auricle is involved, the disease may spread to the auditory canal, completely occluding it and also causing an inflammation of the middle ear. On the strength of modern researches, it is now generally admitted that erysipelas is caused by bacterial invasion of a wound in all instances (Fehleisen's *micrococcus erysipelatis*). In both of my cases the erysipelas was evidently secondary to the inflammation of the ear. The first patient had an attack of acute suppurative otitis media on Christmas night, but was not seen by me till January 9. Two weeks later the antitragus became inflamed, and on the following day the whole auricle was involved in an erysipelatous inflammation, and was twice its natural size, the auditory canal at the time being less congested and the discharge somewhat diminished in quantity. There was nothing in the canal or middle ear, before the appearance of the erysipelas involving the

auricle and face, to denote anything but a severe case of suppurative otitis media.

The second patient, when first seen, was suffering from acute suppurative otitis media and furuncle of the canal, which had commenced a week before; the inner end of the canal was only slightly inflamed, but there was induration of the tissues in the ante-auricular region. The furuncle was opened, and on the following day an erysipelatous inflammation commenced to involve the auricle.

The general health being below par in both patients, the erysipelas was probably caused, in the first case, by the muco-pus, which, irritating and excoriating the parts, set up an inflammation of an erysipelatous type; while in the second case the disease undoubtedly followed the opening of the furuncle in the cartilaginous meatus, as it is a well-known fact that in debilitated persons erysipelas may follow the most insignificant as well as the most violent injury.

It is also probable that erysipelas of the pharynx may spread to the face by means of the Eustachian tube, tympanum, and external auditory canal, for Morell Mackenzie, in his work on throat-diseases, in speaking of an erysipelatous inflammation of the pharynx, says that the propagation of the malady from the face to the pharynx, and *vice versa*, was observed to take place by four different routes,—viz.: (1) most frequently by the lips and mucous membrane of the mouth; (2) by the nasal fossæ; (3) by the Eustachian tube, the middle ear, and the external auditory meatus; and (4) by the nasal fossæ and lachrymal sac and ducts to the conjunctiva and eyelids. In a case reported by Gull, the erysipelas, spreading from the pharynx, reached the face almost at the same time by the auditory and lachrymal channels. In one case seen by the same author "the affection commenced in the auricle of the right ear and spread through the Eustachian tube to the uvula and left tonsil."

That pyæmia may occur as a complication of acute suppurative otitis media will be seen from the following case, which I have already reported.¹ The patient, aged twenty-three, a clerk, and native of the United States, came to the New York Eye and Ear Infirmary April 14, 1885. He said he had pneumonia on the left side two years ago, but never had any aural disease before. His father died suddenly of phthisis. The present attack commenced six days ago, with earache in the left ear, followed in three days by a discharge, which has been very free for the past two days.

Otoscope Examination.—Left auditory canal filled with muco-pus and congested; lumen of canal diminished and epidermal lining macerated and peeling off. Membrana tympani very hyperæmic, but not well seen. Right membrana tympani dull and retracted. Acoumeter: left ear, one-quarter of an inch; right ear, hearing-distance only fairly good. Tuning-fork on forehead, when vibrating, heard better in the left ear. The ear was syringed

¹ Transactions of the American Otological Society, vol. iii. Part IV.

with a warm solution of bichloride of mercury (one to one thousand), and iodoform was insufflated.

April 27.—Pain less severe at times, but always bad at night; it did not seem to yield to local applications, and, as there were tenderness and redness over the mastoid process, I made an incision an inch and a half long over the mastoid and applied a flaxseed poultice. On the following day the pain was a little easier and discharge somewhat less. Poultice continued, and he was given one-tenth of a grain of sulphide of calcium every three hours.

May 3.—The patient disappeared from observation until to day, when he came to my office looking very badly, and said that on the 28th or 29th of last month he had an attack of nausea and vertigo and slight chilly sensations, but had had none since. Operation on the mastoid advised.

May 4.—Ether given. An incision was made over the mastoid, down to the bone, which was found rough and softened; periosteum separated from the bone, and a small sinus found leading to the mastoid cells. The mastoid process was opened with Buck's drills, and a cavity found, containing two drachms of pus. This was liberated, together with some broken-down tissue, and bone removed by scraping the cavity. The cavity was washed out with a bichloride solution (one to one thousand) and iodoform was insufflated. The wound was kept open by inserting a plug of iodoform gauze, and antiseptic dressings were applied. 8 P.M., temperature 101° F.; respiration 30; pulse 80.

May 7.—Patient given a diet of milk and beef-tea and whiskey several times a day. The temperature rose to 104.6° F. Antipyrine given. Tongue dry, countenance anxious and depressed, eyes sunken, patient restless and irritable. Some delirium at night.

May 8.—Temperature fell to 96° F. under antipyrine. In the afternoon he had a chill, followed by sweating. Temperature 101° F.

May 9.—Quinine substituted for antipyrine.

May 17.—The temperature has varied from 99° to 100° F. in the morning and from 101° to 102.5° F. in the afternoon since May 9. To-day it suddenly rose to 104.4° F.

May 19.—Discharge less from the mastoid. No perforation now seen in the drum-head. Some congestion along the left upper portion of the bony meatus and along the handle of the malleus. For some days past he has had paroxysms of coughing, with scanty muco-purulent expectoration. An examination of the chest gave evidence of bronchial catarrh. Resonance to percussion and vocal fremitus fairly good all over the chest. Respiration catching and interrupted over the left side at the middle of the chest posteriorly and at the apices of both lungs posteriorly; the expiration is somewhat high-pitched and prolonged. The sputum as well as the discharge from the mastoid was examined to day for tubercle-bacilli by Dr. J. L. Minor, but with negative results. For some days past there have been considerable pain on motion and tenderness on pressure at the left shoulder,

the tenderness being especially pronounced on the anterior aspect of the joint, over the course of the pectoralis major muscle. There are a general fulness and induration of the parts about the joint, although the latter does not seem to be involved. There is, however, no sharply-circumscribed swelling. For some time he has complained of pains over the entire body, and it is necessary to raise him very gently in bed.

May 22.—The temperature has not risen over 102° F. Inspiration still catching, almost cog-wheel in type on the left side. No positive evidences of consolidation, excavation, or pleuritic effusion. Shoulder still painful and swollen. A collection of pus, or "cold abscess," unattended by pain or inflammation, discovered to-day very close to the right ankle-joint. This was opened and a superficial abscess-cavity disclosed, running upward and backward for two inches.

May 24.—Patient had two distinct chills this morning. In the afternoon the temperature rose to 104° F.

May 25.—No chills, but the patient sweats a great deal at night. Three more superficial abscesses opened to-day on the right and left thigh and the left leg. Pus dark-colored and fetid.

May 27.—Two more abscesses opened like the others, one on the anterior and lower aspect of the thigh, just above the patella, and containing offensive pus, and the other on the right upper arm, somewhat above the elbow. Temperature this afternoon 103.6° F.

May 28.—During the past twenty-four hours there have been considerable diffuse bogginess and tenderness about the left side of the neck. To-day, the presence of pus being evident, an incision was made deeply into the tissues of the neck at a point three inches from the interclavicular notch, on a line joining the latter with the mastoid process. About three ounces of fairly healthy, thick pus were evacuated, and the abscess-cavity was found to extend upward and backward nearly to the angle of the jaw in front and almost to the tip of the mastoid process behind. It appeared, however, to have no direct connection with the abscess-cavity in the mastoid.

June 1.—To-day he had a well-marked chill, which seemed to be due to a retention of pus in the cervical abscess-cavity. Dr. Robert F. Weir kindly saw the case in consultation and advised opening freely the abscess-cavity, which was done, giving vent to three ounces of pus, and a drainage-tube was inserted. Sulphide of calcium was discontinued, and, at the suggestion of Dr. Weir, the patient was given hydrarg. bichlorid., gr. $\frac{1}{30}$, three times a day, together with small doses of sulphate of iron, and the quinine was reduced to gr. x a day.

June 5.—Patient improving rapidly now. He has no chills, and sweats but little. Temperature lower. The arm is better, but the phlebitis and periphlebitis are gradually extending down the forearm, and the whole arm is cedematous. The tube was removed from the abscess-cavity in the neck.

June 9.—All the abscess-cavities are healing rapidly, as well as the

opening in the mastoid, which discharges but little now. Upper arm much less swollen, but the induration and œdema of the forearm are more apparent. Warm applications continued, and a lead-and-opium wash used. The bichloride of mercury and iron sulphate were discontinued day before yesterday and a tonic substituted.

June 23.—Patient has been walking out every day and gaining strength. All the abscess-cavities have healed, including the mastoid. The phlebitis in the arm has disappeared. The hearing has greatly improved.

July 7.—Patient has gone to the country.

CASE II.—*Acute Purulent Otitis Media from Teething*.—Mrs. C. S. brought her baby, a few months old, to see me on account of a discharge from both ears, of a month's duration. The baby was teething. There has been a large swelling above and behind the right auricle for some time. An examination showed presence of pus in both auditory canals. There was well-marked fluctuation over the abscess. An incision was made in it at a point just above the upper wall of the auditory meatus and close to the auricle. Considerable pus escaped, and more or less blood. With a probe it was found that the bone was bare. A tent of lint was inserted in the opening, and I ordered that a flaxseed poultice be applied. She was also told to syringe both ears with warm water and afterwards to instil drops of zinc sulphate (gr. ij—fʒi) into the ears.

December 17.—The bare bone was found covered now, and the sinus closing. The ears discharged less. The poultices are to be discontinued, and the tent was taken out of the sinus, which was allowed to close. The child was ordered cod-liver oil.

CASE III.—*Acute Suppurative Otitis Media followed by Mastoid Disease*.—Maurice G., aged forty-six, a cigar-maker, consulted me March 30, 1888, and said that two years ago he first became deaf suddenly. He was treated at a dispensary and cured at the end of two weeks. He had no further trouble with his ears until two and a half months ago. At that time he noticed he did not hear well with the right ear, which discharged freely. This remained so for about two weeks, when the other ear began to discharge and the hearing became affected. When the left ear began to discharge the right ear began to heal, and in a week all discharge from it ceased. The left ear continued to trouble him, and at the same time the tissues behind and below the auricle became inflamed and boggy. This continued to grow steadily worse. There are at present severe pain behind the ear and tenderness on pressure. Discharge from the ear slight. He has also pain in the frontal and occipital regions.

March 31.—After etherization, I enlarged an incision which had been made the day preceding over the mastoid and down to the bone, as the patient was relieved but little, the temperature remaining at 99 $\frac{2}{3}$ ° F. Pulse 120. He also complained of being chilly. I pushed back the periosteum, and with a mallet and chisel made a large opening directly behind the meatus, and found pus and broken-down tissue in the mastoid cells. The

wound was washed out with a solution of bichloride of mercury, and after a rubber drainage-tube had been inserted was dressed with iodoform-gauze and bandaged.

April 21.—Hearing-distance, watch: right ear, $\frac{2}{60}$ inch; left ear, $\frac{c}{60}$ inch. Sinus behind ear closing nicely. He has had no elevation of temperature to speak of since the operation. Left membrana tympani lustreless, clearing up, with small perforation in posterior inferior quadrant.

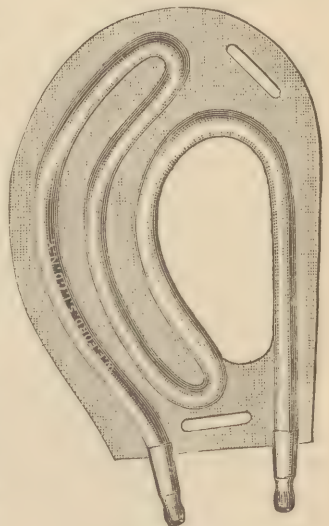
May 1.—Sinus healing rapidly. On the right side the aerial conduction is better than the bony, while on the left side the reverse is the case. Left membrana tympani dull, retracted, perforation healed. He was seen afterwards quite frequently, and on June 30 he heard the same with both ears.

That influenza or the "grippe" has been a frequent cause of ear-disease during the past three years is shown by the number of articles that have been published by otologists during this time in different parts of the world.

The usual symptoms seen in inflammation of the ear are much aggravated. The pain is very severe, attended frequently by a throbbing noise; and when perforation occurs, the discharge—of a serous character—at first contains a considerable amount of red blood-corpuscles. Occasionally vesicles containing blood are seen on the membrana tympani and on the walls of the meatus. The mastoid is more frequently involved in these cases, and very often this occurs simultaneously with acute inflammation of the middle ear.

I recently attended a case where both tympana and both mastoid processes were affected. It occurred in the case of a domestic residing in the family of a physician, several members of whose family had well-marked symptoms of influenza. When called in to see her, I found her suffering from severe pain in both ears, and there was a sero-sanguinolent discharge from each ear. She had had a severe "head-cold," followed in a few days by inflammation of both ears. There were well-marked symptoms of mastoid disease on each side. She had a rapid pulse, with elevation of temperature. She was removed to the infirmary, where she was put to bed and a Leiter coil (Fig. 8) applied over each mastoid. Both ears were douched frequently with a mild solution of boric acid. In a few days all symptoms of mastoid disease had disappeared, and, with astringents, the discharge from the ears was cured. The patient has entirely recovered, and she hears as well as ever. Although this patient made a speedy and complete recovery, the disease is

FIG. 8.



Lleiter coil.

apt to run a more protracted course, the treatment has to be continued for a long time in many instances, and the disease does not yield so readily to the usual remedies and antiphlogistic measures as in the ordinary forms of middle-ear inflammation.

Dr. J. Michel, of Hamburg,¹ has written a paper on some features peculiar to ear-diseases as manifested in Germany during the epidemic of influenza. He forms two classes, the first including those which present the usual symptoms in a case of naso-pharyngeal catarrh, and the second representing the disease itself localized in the ear.

His conclusions are as follows :

1. The aural symptoms in influenza are subjectively and objectively the expression of an intense hyperæmia of the mucous membrane of the auditory apparatus.

2. The chief characteristic of the symptoms of influenza, compared with those of other infectious diseases, in uncomplicated cases, consists in an intense hyperæmia of the organs attacked ; in fact, disproportionate to inflammations from other causes.

3. The hyperæmia is also the indirect cause of the complications observed : first, because, in the weakened walls of the blood-vessels, it tends to rupture and hemorrhage ; secondly, because it lights up afresh an inflammation already healed, or becomes chronic ; and thirdly, it renders the mucous membranes highly susceptible to the reception of other conveyers of infection.

4. The treatment should correspond with the demands of this theory.

5. The name "influenza," or "grippe," may be applied to the recent pandemic, while the ordinary, regular epidemic bronchial catarrhs should be called epidemic catarrhs.

Loewenberg² has also contributed valuable papers on this subject of influenza otitis, in which he maintains that Politzer's method of inflating the middle ear is of the greatest importance in curing this form of inflammation. Enlargement of the cervical and post-auricular glands is present in a certain number of cases, but they rarely, if ever, go on to suppuration.

Diagnosis.—When in the first stage of the disease the membrana tympani presents a hyperæmic condition, no perforation having occurred, we cannot positively make a diagnosis of acute otitis media. To differentiate between acute otitis media and acute myringitis, we depend very much on the severe pain and clinical history in the former, together with the more marked hearing-disturbances.

If we find mucus present in the discharge, we can safely make a diagnosis of perforation and of otitis media, as in a case of otitis externa we should find only a purulent discharge. Inspection by means of the speculum and head-mirror will usually reveal the situation of the perforation,

¹ Deutsche Medicinische Wochenschrift, February 6, 1890.

² Transactions of the American Otological Society, vol. v. Part I.

after the secretion has been carefully wiped away with absorbent cotton on the end of a probe. In some cases, where there is considerable curvature of the canal and all portions of the membrana tympani cannot be inspected, we determine the existence of a perforation by means of the Valsalvan or of Politzer's method of inflation. Sometimes it will be impossible to force air through by either of these methods, as there may be a perforation only in Shrapnell's membrane, or the Eustachian tube may be so swollen that the resistance is too great. In children, where we cannot get a satisfactory examination of the ear, we must rely on the history of the case, the presence of mucus in the discharge, and a perforation-whistle when elicited by Politzer inflation. It must be borne in mind, however, that in some instances the discharge from the middle ear may be entirely purulent in character. In furunculosis of the external auditory canal, we find usually great diminution in the calibre of the meatus, besides considerable tenderness on pressure, even after the furuncle has opened.

It is highly important to determine early whether the mastoid is involved in these cases. Besides severe pain, which is usually much more intense at night, there will be tenderness on pressure over the mastoid process, especially marked over the antrum and the apex of the mastoid. There may or may not be swelling of the tissues over the mastoid. With the speculum we frequently find in such cases a decided hyperæmia of the posterior and upper wall of the bony meatus, with a bulging of the membrana tympani around Shrapnell's membrane.

Dr. E. Pins,¹ of Vienna, has suggested two novel methods of detecting minute perforations in the drum-head. He suggests that an ordinary whistle, such as is found in rubber dolls and other toys, be inserted into the auditory meatus, and upon forcing air through the Eustachian tube the whistle will give forth its note, even if there be but a small perforation. He suggests this method of diagnosis in cases where inspection and inflation, as ordinarily practised, have failed. The second method consists in first thoroughly cleansing and drying the canal and drum-head by means of absorbent cotton, and then filling lightly the auditory meatus with a powder, such as boric acid, lycopodium, etc. Inflation by Valsalva's or by Politzer's method or by means of the catheter will force out the dry powder in a cloud, and by these methods the existence of a perforation may be demonstrated to a class of students.

A case of malignant disease commencing in the middle ear may sometimes be mistaken for an ordinary case of acute purulent otitis media complicated by mastoid disease, as is shown in the notes of the following case reported by me.² The patient, a widow aged fifty-six, came to my clinic on August 3, 1887. She gave the history of previous good health. She has had seven children. She denies having had syphilis or rheumatism. A

¹ Wiener Medicinische Presse, December 30, 1888.

² Archives of Otolaryngology, vol. xvii. No. 1, 1888.

year ago she first noticed deafness in the right ear, with some tinnitus. There was no discharge until March, 1887, but since then there has been a slight watery oozing. Three weeks ago she noticed some swelling in front of the ear, and the pain, which before occurred only occasionally, has now become steady. What alarms her and has brought her here is the facial paralysis which followed the swelling. An examination shows considerable induration and swelling of the tissues in front of the auricle and extending towards the orbit and upward, also below the ear and towards the angle of the jaw. There is also more or less tenderness on pressure just in front of the external auditory meatus, and she complains of a steady, boring pain at a point slightly above and in front of the commencement of the helix. This pain is worse at night, not allowing her to sleep. The facial paralysis is not complete. There is a slight sero-purulent discharge from the auditory canal; the walls of the latter are so indurated and swollen that a view of the membrana tympani cannot be obtained. A probe introduced carefully enters to the usual depth, causing no pain, but considerable hemorrhage. The artificial leech was applied, and she was directed to syringe the ear frequently with hot water. She was also given hydrarg. bichloride (gr. $\frac{1}{24}$) and potas. iod. (gr. x) three times daily.

November 2.—I saw her for the first time to-day. She has been under the care of my assistant. I found that she could hear loud voice with the right ear, and the tuning-fork, when placed on the vertex, was also referred to the same ear. Bony conduction was also better than aerial conduction for the affected ear. The facial paralysis is now complete, and the pain and swelling about the ear are more marked. The right tympanic cavity contains dark, bleeding granulations. The left membrana tympani is dull, retracted, and thickened; cone of light small. The tissues over the mastoid process are indurated, and on making firm pressure over the apex of the mastoid there is some deep-seated pain. I made a Wilde's incision about one and a half inches long, and found denuded bone and an irregular opening about one-fourth of an inch in diameter leading to the mastoid cells. There were no sequestra of bone nor pus; the cells seemed filled with a spongy tissue. A poultice was applied, and opium was given to relieve the pain at night.

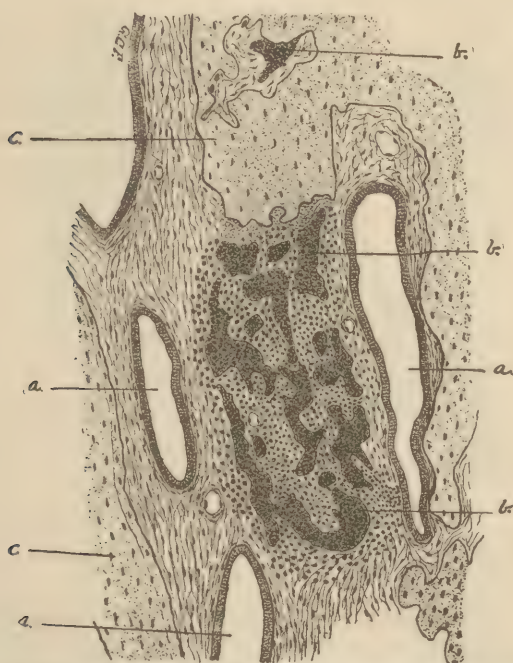
The patient entered the infirmary as an inmate on November 8, as the pain continued to be severe and the swelling remained the same. The case was seen in consultation by Dr. A. H. Buck and Dr. R. F. Weir. Although the possibility of its being malignant disease was discussed, it was considered more probable that it was a case of extensive caries, with chronic inflammation and induration of the surrounding tissues. The canal was still very much contracted, and the introduction of the probe into the middle ear at this examination, as before, caused considerable hemorrhage. It was decided to syringe the ear and mastoid cells several times a day with a boric-acid solution, and to continue the morphine to relieve the pain at night. This plan of treatment was continued for from ten days to two

weeks, when, as the pain persisted and there was no change in the induration of the tissues, etc., with Dr. Buck's concurrence, I decided to explore more thoroughly the mastoid cells.

Ether given. I enlarged the previous incision by carrying it upward to a level with the upper border of the pinna and downward as far as the lower extremity of the lobule. The tissues divided were as dense as cartilage. The mastoid contained loose sequestra of bone and soft tissue. These were removed and the cavity scraped with a sharp spoon, so that I was able to introduce easily the little finger into the mastoid cavity. I cut off a slice of the cartilage-like tissue over the mastoid process for microscopical examination. The cavity was then thoroughly washed out with a solution of carbolic acid, the water syringed in passing readily through the antrum and escaping by the external meatus, and *vice versa*. Iodoform was insufflated and a bandage applied.

December 15.—The wound was dressed on the second day after the operation and a drainage-tube inserted in the mastoid cavity. The syringing with carbolic-acid solution and the insufflation of iodoform have been carried

FIG. 9.



a, a, a, mastoid sinuses; *b, b, b*, carcinoma; *c, c*, bone trabeculae.

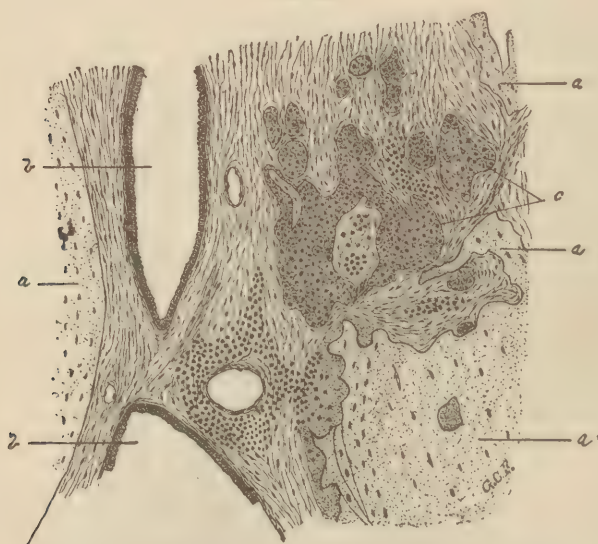
out twice a day. There has been much difficulty in preventing the sinus from closing. She has been taking a tonic of iron, strychnine, and quinine, besides milk and a nourishing diet. Since the operation the pain at night has been less severe.

The slice of tissue removed at the operation was examined by Dr. Richmond Lennox and pronounced carcinomatous. He says in his report, "It is of the fibrous or scirrhus variety, and as yet the groups of cells characteristic of such growths are small. But it is very distinct, and although in some places there is a moderate amount of cellular infiltration (leucocytes), there seem to be no signs of any breaking down."

February 22.—The disease has gradually extended, and the patient returned home, where she has been in bed ever since. There is now great pain in the upper temporal region and vertex. The pinna has become swollen to a great size, and is of a black color. The meatus is dilated, and the cut behind the ear has nearly healed. A large swelling now exists below the ear, on the neck. She swallows with great difficulty. She has hemiplegia of the right side. Her speech is affected and her mind wanders.

For these sections, made from a portion of the bony tissue removed from the mastoid cells, and for the drawings of the same (Figs. 9 and 10), I am indebted to my friend Dr. George C. Freeborn.

FIG. 10.



a, a, a, a, bone trabeculae; b, b, mastoid sinuses; c, carcinoma.

Prognosis.—The prognosis depends very much on the condition of the patient's general health, and also whether it is a simple case of acute purulent otitis media following a naso-pharyngeal catarrh, or not. In a healthy individual, and when the disease proceeds from a cold or a naso-pharyngeal catarrh, the prognosis is generally good. Cases in which an unfavorable prognosis should be given are those occurring in cachectic, scrofulous, tubercular, and syphilitic patients; also in those suffering from diphtheria and scarlatina, typhus fever and measles, especially in scrofulous children. A

favorable prognosis should also be guarded in some cases occurring during epidemics of influenza.

The following should be considered as unfavorable symptoms: continuance of the pain after the disease has lasted for several weeks, and of a distressing tinnitus; bleeding from the ear, due generally to the presence of granulations; great loss of substance in the membrana tympani; swelling of the bony meatus, with symptoms of mastoid disease; the occurrence of caries of the antrum and ossicles, and facial paralysis and swelling of the glands about the neck.

Treatment.—The patient should in all cases be kept quiet and confined to the house, and in severe cases should be put to bed. A mild laxative should be given, and all stimulants and a rich diet should be forbidden. The action of the skin should be promoted, and, as there is apt to be some elevation of temperature in these cases, small doses of Fleming's tincture of aconite should be given. The aconite will be found of great service, especially in cases following a cold. When there is considerable secretion in the naso-pharyngeal cavity, I have found tincture of pulsatilla in one-drop doses, repeated often, of benefit in a number of cases. This remedy may be given in alternation with tincture of aconite where fever exists.

If called to see an adult suffering from pain in the early or hyperæmic stage, we can frequently abort the inflammation by applying at once my artificial leech, which I have already described in speaking of the treatment of acute catarrhal otitis media. It should be applied in front of the tragus and close to it. When there are symptoms of mastoid disease, it should also be placed over that process. If this abstraction of blood does not abort the disease, it will at least be apt to run a much less severe course. Buck,¹ in speaking of the treatment of acute purulent otitis media, says that "in place of leeches we may employ with equally good effect, and with greater safety and comfort, the Heurteloup artificial leech or the recently-contrived apparatus of Dr. Gorham Bacon." This very simple contrivance answers the desired purpose admirably, and the good results obtained from its use by my associate Dr. Huntington Richards justify me in recommending it unreservedly (see page 291).

The advantages of the procedure over the plan of abstracting blood by natural leeches are these: the necessary instruments are already at hand, while leeches are not always easily obtainable; there is nothing repelling about the operation, whereas many patients have a decided objection to the employment of living leeches upon themselves; there is no after-bleeding when the artificial leech is used, while the bleeding from leech-bites is sometimes very difficult to control; and, finally, much less time is consumed in the management of the whole business than is the case when natural leeches are used.

Frequently, in children, we can relieve the pain by instilling into the ear,

¹ Manual of Diseases of the Ear, p. 225.

through a medicine-dropper, hot water; and in some cases, not only of children but also in adults, we may syringe or douche the ear every hour or two with hot water, with great relief to the patient. The ear should be frequently examined, and as soon as we find any bulging of the drum-head, which occurs most frequently in the posterior half, we should incise the membrane with a paracentesis-needle, selecting usually its posterior inferior quadrant or its most bulging point. After this has been done, it may be necessary, should the secretion be very thick, to force it out by means of Politzer's method of inflation. This should be frequently done during the course of the disease, very gently if there be much pain or in delicate subjects, and more forcibly in cases where the severe pain has subsided and there is more or less obstruction to the entrance of air through the Eustachian tube.

After paracentesis has been done, the discharge should be promoted by douching the ear with the douche already described under the treatment of acute catarrhal otitis media, with Lucae's double glass tip attached. I usually direct that a heaping teaspoonful of boric acid be dissolved in a pint of water for that purpose, and that the water be as hot as is comfortable for the patient. In some cases where there is profuse discharge it will be necessary to douche the ear as often as every hour or two at first. As soon, however, as the patient is free from pain and the discharge begins to grow less, the douching of the ear should not be done more often than three times a day, and gradually less frequently.

Some relief may be obtained from the pain in the hyperæmic stage by the application of dry heat, such as hot bran, hot salt, or the hot-water bag, and in some cases we may use with advantage drops of atropinæ sulph. (gr. ij), acid. boric. (gr. x), aquæ (f ʒi), which should be first warmed and then dropped into the meatus and a piece of cotton inserted afterwards. In other cases a four-per-cent. solution of cocaine may be used.

After the inflammatory symptoms have begun to subside, I generally use at first a saturated solution of boric acid, which should be warmed and dropped into the meatus several times a day, after the canal has been thoroughly cleansed of any secretion either by syringing or by the use of absorbent cotton on a probe. I generally prefer this method to the so-called dry treatment or the insufflation of boric acid or other powders, in all cases attended by severe symptoms of inflammation and where there is a small perforation in the drum-membrane. In other cases, however, where there is a large perforation and the inflammatory symptoms have not been very severe, the dry method is to be recommended. The powder should be blown in through a powder-blower after the discharge has been removed with absorbent cotton on the end of a probe, but never packed, as pyæmia has resulted from this practice. Various remedies may be combined with the boric acid, such as *hydrastis canadensis*, which I recommended in a paper published in the *Archives of Otolology*,¹ and which is prepared as

¹ Vol. xii. No. 2, June, 1883.

follows: equal parts of boric acid and tincture of *hydrastis canadensis* are thoroughly mixed and the mass evaporated to dryness; then the residue is thoroughly pulverized and mixed again with equal parts of boric-acid powder. The dry method should never be used in cases where there is a profuse discharge containing considerable mucus. In these cases, and in others where the powdered boric acid has not succeeded in checking the discharge, astringent solutions should be used, such as zinc sulphate (gr. ij-iv-fʒi) or plumbi acet. or cupri sulph. in the same strength as the zinc. If after using sulphate of zinc several days, the discharge remains the same, we should try the lead or copper solution.

Politzer¹ recommends injections of warm water through the catheter into the middle ear in those cases in which the pain continues uninterruptedly after the perforation of the *membrana tympani*, in spite of palliative treatment; in which the suppuration cannot be arrested by the local treatment described; in those obstinate forms in which the perforation is situated on a nipple-like elevation of the *membrana tympani*; and, lastly, in painful inflammations of the mastoid process.

If, in the course of acute suppurative inflammation of the middle ear, symptoms of mastoid disease become pronounced, such as pain and tenderness on pressure over the mastoid or with decided hyperæmia of the posterior and upper wall of the bony auditory canal, I cannot speak too highly of the good results I have obtained, in such cases, from the use of Leiter's apparatus, as shown in Fig. 8. The patient is put to bed and the coil applied over the mastoid, and ice-water, by the siphon principle, is allowed to run through the coil by means of rubber tubing attached to it. I have cured many cases of incipient mastoid disease in this manner. I always recommend in these cases that the ear be continually douched with hot water as part of the treatment. The coil should be removed every now and then and kept off for two or three hours, to see if there be any return of the pain. If, in spite of this plan of treatment, the pain persists and we have no distinct evidence of the formation of pus, my artificial leech should be applied over the mastoid before we resort to a Wilde's incision. As soon as we feel sure that suppuration has begun in the mastoid cells, or if the pain continues in spite of the treatment already described, we should lose no time in laying open the mastoid cells with the mallet and chisel. This operation is more fully described elsewhere.

In some instances granulations form on the margins of the perforation or in the middle ear. To remove these, applications may be made by touching them with a drop of tincture of chloride of iron on the end of a probe, or nitrate of silver or chromic acid fused on the point of a probe may be used in the same way, but great care should be taken that nothing but the granulation be touched with the chromic acid.

After the perforation in the *membrana tympani* has healed, it will be

¹ Diseases of the Ear, p. 403.

necessary to continue the treatment by inflating the middle ear by Politzer's method, or by means of the catheter, at first four or five times a week, then every other day, and gradually less frequently.

It is of the highest importance to attend to the patient's general health in this disease as in acute catarrhal otitis media. Any disease of the anterior nares or naso-pharynx should be relieved, such as catarrh, enlargement of the turbinated bones, adenoid growths, etc., and tonsils, when chronically enlarged, should be excised.

Soothing gargles and sprays will be required in cases of inflammation of the pharynx, and in some cases where the discharge shows a tendency to become chronic and the patient is a catarrhal subject it will occasionally be necessary to recommend a change of climate.

CHRONIC CATARRH OF THE MIDDLE EAR:

INCLUDING PREVENTIVE HYGIENE.

BY SAMUEL SEXTON, M.D.,

New York City.

NATURE.

OTITIS media catarrhalis chronica, or chronic catarrh of the middle ear, is an affection of the tympanic cavity characterized *pathologically* by gradual and progressive structural changes in the mucous membrane and the adjacent connective tissue, these changes taking primarily the form of cellular proliferation, organization of new tissue, and hypertrophy, and secondarily the form of contraction of the new-formed tissue and atrophy. *Clinically* it may be defined as a chronic, non-suppurative inflammation of the middle ear, associated with progressive deafness, tinnitus, and other evidences of altered auditory function, and with vertigo, and accompanied by characteristic objective changes in the lustre, color, consistence, tension, and curvature of the membrana tympani.

As will be seen later on, the pathological changes induced by this disease present very great variations; and authors, upon the basis of these variations, have proposed a number of names for the affection itself, and in some cases even have regarded the latter as actually representing two or three distinct forms of disease. Thus, the forms associated with excess of secretion are frequently distinguished, under the name of "chronic exudative" or "moist" catarrh, from the so-called "dry catarrh;" and similarly a distinction has been made between a hypertrophic and a sclerotic otitis. As descriptive terms these titles are convenient, and in a certain sense, too, represent distinct pathological conditions; but so many intermediate forms exist between the typical states which they designate, and, furthermore, the moist and the dry or the hypertrophic and the sclerotic processes so frequently succeed each other in the course of the same case, that their separation as distinct diseases becomes untenable, and they can only be regarded as varying manifestations of the same pathological state. If we add to this the fact that it is often impossible to differentiate these conditions by any peculiarity in their clinical symptoms or even in their objective characters,

the propriety of their consideration under one common title becomes obvious.

The term catarrh or catarrhal inflammation, here adopted for these varying conditions, has the advantage that it is generic, inasmuch as it does not, like the terms "exudative" and "sclerotic," limit itself to any one aspect of the morbid process; and the further advantage that it indicates the relation existing between the inflammation of the drum and the similar inflammation (catarrh) of the mucous membrane of the respiratory tract. This relation, as we shall see, is not only one of identity of pathological character, but also one of cause and effect. In fact, so intimate is this relation that we find ourselves compelled to regard catarrh of the ear and catarrh of the naso-pharynx as simply varying manifestations of the same disease, which, however protean in the symptoms to which it gives rise, and wherever it may be localized, has the same causation and presents the same anatomical features.

From the outset, then, it must be borne in mind that catarrh of the middle ear is not a mere local process, confined from beginning to end to the tympanum, but is one (and but one) of the many forms in which catarrh asserts itself. In other words, it is the result of a general inflammatory tendency affecting the whole pneumatic cavity of the head and throat,—of which cavity the Eustachian tube, tympanum, and mastoid cells form a small outlying district. All parts of this pneumatic cavity, which also comprises the nares, upper pharynx, fauces, and larynx, may not, of course, be equally liable to inflammation; and hence we may find catarrh of the middle ear unassociated with any very obvious changes in the naso-pharynx, just as we may also find a pronounced condition of nasal hypertrophy or of granular pharyngitis without simultaneous involvement of the tympanum. But it is also exceedingly common to find several or indeed all parts of the pneumatic tract affected either conjointly or in succession; and in any event, when this is not the case, it is fair to infer that the immunity of the unaffected districts is due, not to the absence of an exciting cause acting upon them, but to a greater resistance in the tissues themselves. This view of the case is borne out by the great mass of our observations upon the subject; and increasing experience has tended still further to confirm it.

The conclusion which flows almost inevitably from this conception of the nature of catarrhal inflammation is that behind this generalized inflammation there must lie a general cause; that catarrh, however localized, is the result of a perverted condition of the general system. Whether, as is often done, we dignify this condition by the name of a diathesis, or content ourselves with recognizing its existence without speculating upon its nature, we must still admit the important bearing that it has upon the genesis, course, and treatment of middle-ear catarrh. At the same time, we must not allow this view of the case to carry us too far and lead us to conceive of catarrhal otitis as nothing but the local manifestation of a distinct con-

stitutional disease, such as syphilis or tuberculosis. The catarrhal diathesis, even if we allow the propriety of such a term, would appear to mean nothing more than a special tendency to the development of the type of inflammation that we call catarrh, or, in other words, an enfeeblement of the mucous membranes throughout the respiratory tract, rendering them prone to become inflamed upon slight provocation. Since this enfeeblement or diminished resistance upon the part of the mucous membranes is general, we consider it to be due to a constitutional cause; but this constitutional cause itself may be, and in fact very frequently is, the result of local conditions. That is, it is the outcome of climatic conditions; of the unnatural ways of living imposed by the demands of modern civilization, producing mental and physical overstrain; of malnutrition from unhygienic surroundings and improper food; or, as is frequently the case, of a combination of all of these conditions. The result of all these causes, especially if their action is repeated or is constant, is to produce a state of systemic depression, or lowering of the general vitality, which depression in its turn reacts upon the mucous membranes, rendering them less able to resist the morbid agents which act as the exciting causes of catarrh. Such a state of systemic depression, however inveterate it may become by the repeated action of the agencies that give rise to it, cannot obviously be regarded as anything innate or, in the strictest sense of the word, constitutional: it is rather the product of the environment, or of accident. Hence the term diathesis seems hardly applicable to it; at most we can speak of a catarrhal tendency which is the result of systemic depression from a great variety of causes.

The same causes which predispose to the development of catarrh tend to make themselves felt in other ways also and give rise to symptoms referable to the involvement of other structures besides the mucous membranes. Chief among these symptoms are those of nervous disturbance. Patients with catarrhal disorders are very frequently neuropathic; they give evidence, that is, of a waste of nervous energy. This evidence may take the form of nervousness, excitability, or irritability; or it may assume the guise of insomnia, neuralgia, or some other neurosis. When, however, such neurotic conditions occur in connection with aural catarrh, it is often impossible to say how far they are produced by the general state which gives rise to the latter and how far they are due to the catarrh itself; for, as will be seen later on, chronic catarrhal otitis and the associated catarrhal states of the nose and throat may induce the most various nervous symptoms. All that can be said in general is that catarrh is often associated with neuroses, and is especially apt to develop in persons of a neurotic tendency, and that when developed it is likely to aggravate the neurotic state already existing or to give rise to new neuroses.

Nothing certain is known of the means by which the general state predisposing to catarrh engenders an actual catarrhal inflammation. Doubtless the change from the non-inflamed to the inflamed state is effected in

some way by the nervous system; and we may be allowed to conjecture that it is some sort of trophic change that is produced.¹ But such statements as these, although useful in their way, really convey no idea of the actual process by which a condition of general lowered vitality brings about a definite and circumscribed pathological change like catarrhal otitis.

Summarizing the conclusions arrived at in the preceding paragraphs, we may now present a third definition of catarrhal otitis media, based upon the *nature of the morbid process*,—namely, that it is a chronic trophoneurosis of the mucous membrane of the middle ear, occurring coincidently with similar trophoneuroses of the entire pneumatic system of the head and throat, and with other neuroses; all of which conditions are dependent upon a lowering of the general vitality due mainly to the continuous action of unfavorable climatic and hygienic surroundings.

ETIOLOGY.

The causative factors of aural catarrh have been to a greater or less extent summarized in the preceding paragraphs. It will, however, be desirable to take up the consideration of these factors a little more in detail. In doing this we shall follow the customary plan of distinguishing the causes into predisposing, or remote, and exciting; premising, however, that in this as in many other diseases the same morbid factor may act both as a predisposing and as an exciting cause.

The *predisposing causes* of chronic catarrhal otitis may be broadly stated as comprising all circumstances which tend to produce a permanent depression of the vitality of the body. They include, accordingly, the greatest variety of factors, some of which, however, act far more frequently than others in producing the disease, and hence demand a more detailed description.

Heredity has been alleged to constitute one of the most frequent and potent of the predisposing causes, the tendency to acquire the latter being therefore regarded as something innate and independent of the environment. If this were the case, we should have to concede the existence of a distinct catarrhal diathesis or constitutional disease analogous to tuberculosis or syphilis. Our own observations do not lead us to concur in this view. Aural catarrh, it is true, does often occur in several members of the same family, and may also occur in successive generations. But the exceptions to this mode of occurrence are very frequent, and in those cases in which it does take place we can almost always find that the different individuals

¹ Among the evidences that point in this direction is the fact, frequently observed by the author, of the production or aggravation of aural catarrh by reflex irritation (*e.g.*, by the presence of carious teeth). Such a connection between remote structures seems pretty certain proof of the possibility of the development of catarrh through nervous influence. Moreover, the often sharply circumscribed nature of catarrhal inflammations seems to indicate a limitation to the area of distribution of some special nerve.

affected have been subjected to the action of the same climatic or hygienic influences, which in themselves are quite sufficient to account for the development of their catarrh. It is admitted, of course, that a state of impaired vitality, however induced, may be transmitted from parents to children, and that such a congenital impairment of the resisting power may predispose to catarrh just as much as would a similar condition acquired in after-life. But the fact that a feeble father begets a feeble son, and that both, on account of their lack of stamina, acquire catarrh, is a very different thing from the transmission of a specific tendency towards catarrhal inflammation from one generation to the next. Heredity of the former kind does occur, although probably less often than is imagined; heredity of the latter sort is, in our opinion, rarely, if ever, met with.

Age has an undoubted influence in predisposing to chronic aural catarrh. The exact extent of this influence is, however, pretty hard to determine. In a table elsewhere published,¹ the following figures are recorded:

NUMBER OF PATIENTS WITH OTITIS MEDIA CATARRHALIS
CHRONICA CLASSIFIED ACCORDING TO AGE.

Age.	Males.	Females.	Total.
Under 5	17	8	25
5 to 10	32	44	76
10 to 20	137	146	283
20 to 30	252	222	474
30 to 40	200	152	352
40 to 50	157	126	283
Over 50	182	116	298
Total	977	814	1791

In attempting to analyze a table of this sort, two facts must be borne in mind. The first is that these figures represent a much higher percentage than is at first sight obvious of patients in middle and advanced life suffering with aural catarrh. For if we suppose these 1791 patients to represent a total population of 10,000, 4900, or nearly one-half of the latter, will be below the age of twenty, and yet these will comprise only 384 of our patients as against 1407 among the other 5100. In other words, it would appear as if people above the age of twenty are nearly four times as apt to be affected with aural catarrh as those below that age. The following table, constructed upon the supposition that our 1791 patients represent a total population of 10,000,² shows the proportion of catarrhal patients at a given age to the total number living at that age:

¹ Sexton, "The Ear and its Diseases," William Wood & Co., New York.

² The selection of this number is, of course, entirely arbitrary; but whatever number is chosen, and to whatever extent, consequently, the absolute value of the percentages may vary, their relative values when compared with each other remain unchanged, so that the argument is not affected by the necessarily arbitrary character of the assumption.

Age.	No. living.	Otitis media catarrhalis chronica.	Percentage.
Under 5	1430	25	2
5 to 10	1249	76	6
10 to 20	2289	283	12
20 to 30	1770	474	27
30 to 40	1265	352	28
40 to 50	912	283	31
Over 50	1085	293	27

As chronic catarrhal otitis is not a disease which gets well spontaneously, so that those who have it once have it always, and as, moreover, it does not in itself cause death, so that patients affected with it do not die faster than other people, it is fair to infer that where the percentage remains the same between any two ages no new cases have developed within the included period, and that when there is a decided increase in the percentage the difference represents approximately the number of new cases which have developed, or at least have become noticeable, between the ages specified. Hence it would appear from an inspection of the table just given that after the age of thirty there is little if any new development of the disease; that most of the cases develop between the ages of twenty and thirty; and that the next most prolific decade is that between ten and twenty. In a general way, doubtless, these deductions are true; but we must never forget that statistics of this sort cannot be accepted unreservedly. For, in the first place, such figures represent only the severer cases of catarrhal otitis,—*i.e.*, those which seek medical treatment. Now, as the disease is one which tends to grow worse with age, it may very well happen that a case which at the age of twenty was so slight as to afford no symptoms calling for treatment might, twenty years after, have become pronounced enough to come under the doctor's observation; so that a disease which really began in youth is credited with starting in middle life. Hence there is probably a greater preponderance of cases commencing in early life than even the table would indicate. Again, the numbers given at the extreme limits of the table are probably below the true amount, because, on one hand, in children deafness is very frequently overlooked or is not attributed to its true cause, and so is not made a matter of treatment; and, on the other hand, in the very old, any form of deafness is apt to be attributed to the effect of advancing age and is accepted as inevitable and incurable. Obviously, then, we can draw no hard-and-fast conclusions from statistics like these; but we may say in general that otitis media catarrhalis chronica is a disease which commonly begins in early life (before the age of twenty), and that the numerous cases which we observe in middle and advanced life are in many instances, if not in the majority, the later stages of an affection which has begun long before. This deduction has an important bearing upon prognosis and treatment.

In considering the relations of aural catarrh to age, we must not neglect to take into account the degenerative processes naturally associated with

advancing years. These processes produce a physiological decadence of function (deafness) which altogether resembles that due to catarrh; and when, as often happens, they occur in conjunction with a moderate catarrh, it is frequently quite impossible to determine how far the symptoms are due to the physiological rigidity and atrophy of the tissues, and how far they are the result of the pathological inflammation. Age, therefore, not only renders inveterate a catarrhal process which has already begun, but also adds a disturbing element of its own in the shape of this natural degenerative process, which serves to aggravate still further the symptoms produced by the former; and, moreover, the tissues, owing to this degeneration, are less likely to undergo repair, so that in such cases the prognosis also is rendered essentially worse.

Climatic conditions have an important bearing upon the production of chronic catarrhal otitis. Climate is mainly dependent upon three factors,—namely, temperature, humidity, and barometric pressure; and each of these factors, together with the electrical and other variations to which they give rise, is of importance in determining the genesis of catarrh. It has long been recognized, however, that the disturbing effects of climate are based not so much upon the absolute pitch or yearly range of the temperature, humidity, and pressure, as upon the suddenness with which these conditions are apt to vary at any one time. It is a matter of common experience that changeable weather is most favorable to the development of colds; that catarrhal affections of all sorts are rife in the transition-period of autumn, and still more in the spring, with its sudden alternations of heat and cold, dryness and moisture. It is also notorious that those localities which are particularly liable to such changes are the ones that are most afflicted with diseases of this nature. Hence the unenviable prominence that our Atlantic seaboard has won for itself in this regard,—a prominence which it shares with almost all maritime lands in the temperate zone.

It is beyond the scope of an article like this to enter into any minute inquiry as to the way in which atmospheric changes induce catarrh. It is sufficient to say that the most usual way in which climatic conditions cause systemic depression is by sudden chilling of the surface of the body when not prepared for the action of cold. Refrigeration of this sort is most usually produced by a draught of air; and the absolute temperature of the latter is not nearly of so much importance as its relative temperature compared with that of the body. That is, a comparatively warm breeze acting upon a skin which is relaxed and perspiring from the effects of heat exerts a much more decided cooling tendency than the cold wind of winter striking a non-perspiring, bloodless surface. This fact helps us to understand why variations of atmospheric temperature should exert so marked an influence in the genesis of catarrh; for, on the one hand, such variations predispose to the development of currents of air or draughts, and, on the other hand, a sudden rise of atmospheric temperature puts the body in a state of warmth and relaxation that renders it least able to resist the effect of the draught

or of any sudden depression of the atmospheric temperature that may follow the rise.

The local impression produced by refrigeration may be profound or slight; the difference depending, doubtless, upon differences in individual susceptibility, which cause the same degree of exposure to be followed in one case by no ill effects whatever, in another by a cold in the head, and in a third by an attack of pneumonia. Other things being equal, persons who are run down by disease or other causes are much more susceptible to changes of temperature. Susceptibility is also largely a matter of habit, so that by constant exposure to thermal variations even feeble persons may become so used to them as to suffer no ill effects from changes that would give another, perhaps more robust, individual a severe cold. Perhaps this influence of habit may serve in part to explain the fact that chilling of those parts of the body which are not usually exposed to the air, as the scalp, occiput, and feet, is so much more likely to induce a cold than is chilling of the constantly-exposed face and hands.

The presence of an undue amount of moisture in the air greatly increases the depressing action of both heat and cold, and intensifies the effect produced by a change of temperature. Hence the damp air of our Atlantic coast is specially provocative of catarrh; and the same may be said with even greater force of the moisture-laden atmosphere of the tropics, in which very slight changes of temperature often suffice to produce great constitutional disturbance in the unacclimated.

The changes in the atmospheric pressure and in the electrical tension of the atmosphere, which accompany the variations in temperature and humidity, are without doubt responsible for some part of the injurious influence exerted by the latter. How much effect is to be ascribed to them has not as yet been determined with certainty. Still less is known about the action of the accidental constituents of the atmosphere, such as ozone, ammonia, and those omnipresent but inscrutable organisms, the bacteria. The effect of suspended matter in the air, such as dust or particles of organic matter, which act as direct irritants to the naso-pharyngeal mucous membrane, is more properly considered under the caption of the exciting causes of catarrh.

The climatic variations provocative of catarrh may be natural, like those that we have been considering, or they may be artificial, as when a man travels from one climate to another or passes from the hot, dry air of the house to a damp and chilly atmosphere outside. Sudden alternations of this sort constitute one of the most prolific causes of surface-refrigeration, and hence of catarrh. We live most of our life in an artificial climate and habituate ourselves to unnatural conditions. We accustom our skin and respiratory tract to constant contact with air overheated and devitalized by stoves, steam-pipes, and furnaces. The consequence is that not only are the cutaneous and mucous surfaces depressed and rendered less resistant to harmful influence, but in addition the contrast when we emerge

from these abnormal surroundings and enter a natural atmosphere is so great that the surface readily becomes chilled, and the system, already depressed by its hot-house environment, receives a morbid impression which results in the establishment of catarrh. A still more pernicious alternation of natural and artificial climates is that which many of us are obliged to encounter daily on the ferry-boats or cars, which, being almost always either over-heated or under-heated, and either very ill ventilated or constantly filled with draughts, furnish the ideal conditions for chilling of the surface and for the generation of catarrh.

Closely allied to the depressing influences of an unhealthy and variable climate are those induced by *unhygienic surroundings and methods of living*. The effect of this factor is very apparent among the poorer classes in our large cities, where over-crowding, bad air, and insufficient or improper food produce a great contingent of sickly and anæmic persons who habitually suffer from catarrhal troubles. But the malign influences of unhygienic ways of living are by no means limited to the poorer classes: they affect rich and poor alike; and, as they fall among the preventable causes of catarrh, they become of considerable interest from a therapeutic point of view and demand a detailed investigation. We shall accordingly examine each one of the causes of physical depression falling within this category, and endeavor to ascertain how far it is responsible for the development of catarrh.

The inhalation of bad air has been regarded as a frequent cause. It operates among the poor, who are crowded together day and night in badly-ventilated and uncleanly rooms; among lawyers, judges, and others who frequent courts and other public buildings which are very apt to be filled with vitiated air; and generally among the inhabitants of our cities, where the atmosphere is contaminated all the time by the emanations from manufactories and by all sorts of exhalations and dust.

A cause so wide-spread would seem to be very potent, but it may well be doubted if, after all, it has all the influence that is attributed to it. Wherever it does act, it is associated with other causes still more powerful, which must be made largely accountable for the ill effects that seem to result from it. Thus, our tenement-house population, although universally exposed to its influence, appear to suffer but little deterioration until other agencies, such as bad food, lack of exercise, exposure, and over-exertion, are superadded. Our Italian and Chinese immigrants, who sleep in apartments crowded to their utmost capacity and discard ventilation altogether, are, as a rule, a sturdy, healthy body of men. And even those of us who are used to a much more liberal supply of air must have often remarked that the depressing influences of a close room were dependent rather upon its devitalization by heat (especially the dry heat of furnaces and steam-pipes) than upon any vitiation due to defective ventilation. Indeed, it would seem that in many cases excessive ventilation, by furnishing an exciting cause of catarrh, in the shape of draughts, may be more prejudicial than

deficient ventilation, which, by depressing the vital stamina, acts as a predisposing cause.

The effect of bad drainage and filth is also not easy to estimate, and is also very likely but slight. Acute diseases, like typhoid fever, may possibly be generated by the retention of noxious products in the patient's vicinity; but that a state of chronic systemic depression, such as would render one liable to catarrhal troubles, is induced by any such cause seems problematical.

Diet has an important bearing upon the genesis of catarrh. Errors in this respect are very frequent, particularly among children. Sometimes the food taken is insufficient in quantity; much more commonly it is excessive in amount and at the same time defective in quality. Children of all classes are habitually over-fed, and that, too, with very indigestible stuff. The starchy and saccharine constituents are often largely in excess, the result being indigestion, fermentation of the unused portions of food, and consequent flatulence. Healthy children who take plenty of exercise are able to stand this strain upon the digestive and assimilative organs; their more delicate associates, and those who are compelled by attendance at school or by other reasons to lead a sedentary life, are apt to become thin and pale, to acquire a bloated and sodden look, and upon slight provocation to develop catarrhal inflammations which do not readily get well. In such cases we have had frequent occasion to remark that treatment for the catarrhal trouble was of no avail until the mode of life had been radically changed. In adults the same causes are operative, only in a somewhat different way. With them the quality of the food is more apt to be suited to their needs; but the quantity is often excessive, and the excess is thrown upon the system all at once, the stomach being heavily overloaded at dinner by a mass of stuff which it is not competent to digest. The other meals, which are slighted in comparison, are often bolted in a hurry, so as to give rise to indigestion; and it frequently happens that severe mental or physical work is taken up directly after heavy meals, thus markedly interfering with the digestive processes. All these conditions contribute to produce a state of the system which, whether characterized by plethora or the reverse, is extremely favorable to the development of catarrh and to its continuance when developed. Another dietetic error to which adults are extremely prone is the excessive use of some form of stimulant, whether tea, coffee, tobacco, or alcohol. The last two are capable of producing upon long-continued use a profound systemic effect, one of the evidences of which, particularly in those who indulge much in alcoholic beverages, is a marked tendency to catarrhal inflammation.

Another feature of every-day life that has a marked depressant effect upon the vital energy is excessive mental and physical strain. The demands made upon most of us, especially in the larger cities, by the conditions of modern existence produce an expenditure of energy which is often largely in excess of the supply that the depreciated system is able to

furnish. The severity of the competition in all branches of business and in the professions calls for prolonged mental and physical application in those who aspire to succeed. This leaves little time for exercise and relaxation, and often too little time even for sleep. Thus both the expenditure of energy is increased and the means for its restoration are curtailed. In addition, with many the struggle for existence is so severe that they never get rid of the sense that they are dependent even for a bare livelihood upon unremitting exertion or upon the precarious support of a continued good fortune. The anxiety and worry thus engendered are powerful depressing agents. Women, who are not, as a rule, subject to business cares, have nevertheless depressing influences quite as great to contend with. Among the wealthy the mental and physical strain imposed by the fashionable life, with its late hours, its unhygienic conditions, its rivalries and anxieties, is fully as great as that imposed upon men by the exigencies of business. With another class of women housekeeping cares are exacting enough to cause great exhaustion of body and mind; and this is particularly the case among the poorer families, where one woman, being at once cook, housemaid, nurse, and the mother of half a dozen children, has scarcely any rest day or night. The injurious effects of modern life, therefore, are manifold in their origin and in their method of operation; but in all sets of cases, in the overworked and worried man of business, the tired votary of social dissipation, or the wife and mother worn out by household drudgery, the result is the same. The reserve powers of the system are not unlimited, and constant drawing upon them without sufficient renewal will ultimately produce bankruptcy. Depression of nerve-function, with its usual correlative, exaltation of nerve-irritability, sets in. This combined depression and irritability may take the form of those essentially modern diseases, neurasthenia and nervous prostration, or they may occur under the guise of neuralgia, hysteria, dyspepsia, and of almost any functional disorder; but, however manifested, its essential character is the same,—a fact which is readily appreciated when the underlying cause and the happy effects attending its removal are considered. And just as the nerves, the stomach, or other organs are rendered more prone to morbid action and less resistant to morbid influences by this draining away of the nervous energy, so also the mucous membranes have their stamina diminished by the same agency, and are made at once more liable to contract an inflammatory trouble and less active in throwing it off. Accordingly, the sources of this drain—namely, the causes of systemic depression enumerated above as incident to our modern life—are found to exert a marked influence in predisposing to catarrh both of the rest of the air-tract and also of the middle ear.

Chronic diseases, especially syphilis and scrofula, predispose to catarrh. Among seventeen hundred and ninety-one cases tabulated by the author, syphilis was ascertained to exist in six per cent. and probably existed in many more besides. This disease not only predisposes to catarrh by the

depreciation of the system that it induces, but also, through the specific effect of its virus, acts as a direct exciting cause, setting up a syphilitic pharyngitis or otitis media. Children who are the subjects of hereditary syphilis are particularly apt to be affected with catarrhal inflammation of the naso-pharynx and of the ear. Scrofula also acts both as a predisposing and an exciting cause of ear-disease; although in the latter case it is often a chronic otorrhœa that is developed, instead of a catarrhal inflammation. Chronic Bright's disease and gouty and rheumatic affections likewise predispose to catarrhal otitis; and pregnancy or chronic uterine disease may create a similar tendency.

The *exciting causes* of catarrhal otitis are in many cases the same as the predisposing causes enumerated above. In fact, in any chronic disease, and especially in one which, like otitis media, is apt at first to be made up of an apparently discontinuous series of attacks, it is often impossible to distinguish between the influences which render the system liable to disease and those which actually produce it. An otitis media occurring in one who is habitually exposed to changes of temperature may have existed for a long time without attracting attention and then become suddenly noticeable owing to an exacerbation of the symptoms produced by some individual act of exposure. The disease is then said to have been excited by the latter; but in reality it is the combined result of many previous acts of exposure which have, on the one hand, served as exciting causes producing each time a slight unnoticed cold, and, on the other hand, have by their accumulated influence weakened the system so as to predispose the mucous membrane to succumb to future attacks. Hence as the same morbid influence may have a twofold action, at one time attacking the mucous membrane and directly or indirectly exciting it to inflammation, and at another time expending its force upon the general vital energy and so in a roundabout way lessening the resisting power of the mucous surface, we must obviously regard most of the causes already given as both predisposing and exciting. Those which act most prominently in the latter capacity are: exposure to changes of temperature and other climatic variations; exposure to vitiated air, especially such as contains dust and suspended organic matter, which act as a direct irritant to the respiratory mucous membrane; dietetic excesses, and particularly the immoderate use of alcohol and tobacco; mental and physical strain and worry, a very frequent cause of exacerbations in a catarrh already established; disease, including either constitutional affections like syphilis, in which the catarrh is evidently to be looked upon as the result of the local action of the virus that is diffused throughout the system, or local disorders in which the existence of a reflex irritation must be assumed. The class of cases last mentioned, *i.e.*, of those due to reflex irritation, is important both on account of its magnitude and because of the bearing which the recognition of its existence has upon treatment. The organs which may give rise to reflex impulses provocative of aural catarrh are the brain (cerebral disease, mental impressions, fright, shock), the stomach, the genitals

(pregnancy, parturition, menstrual disorders), the naso-pharynx, and the buccal cavity. As an illustration of the influence of the last-named region in the genesis of catarrh, it may be worth while to state that, in about eighteen hundred cases in which there was marked dental caries or other evidence of dental and oral irritation, six hundred and eighty-eight suffered from chronic catarrhal otitis media.

Another cause directly exciting catarrhal otitis is continual exposure to loud noises and repeated concussions. This variety of aural catarrh, which might with propriety be denominated traumatic, is met with in the residents of cities, who live in the midst of constant din and are subject at all times to the shocks and jars incident to urban traffic; in railroad employees and passengers; and in artisans in noisy manufactories. This kind of catarrh is often associated to an unusual degree with an involvement of the internal ear, due, perhaps, to the effect of repeated concussion upon the auditory nerve. In many cases the internal ear is so markedly involved that the affection of the tympanic cavity is either regarded as quite subsidiary or is left out of account altogether. These cases are then placed in a separate category, being grouped under the head of boiler-maker's deafness. But in their essential character, at all events, they do not seem to differ from the numerous cases of ordinary otitis media produced or at least aggravated by constant exposure to noise and concussion.

Finally, aural catarrh may be the direct sequel of another catarrhal inflammation; that is, it may follow directly upon an acute catarrhal affection of the tympanum itself, or it may be consequent upon catarrh of the naso-pharynx. Cases of the first sort—*i.e.*, those in which an acute catarrhal otitis instead of getting well remains as a chronic catarrh—occur chiefly in broken-down and cachectic subjects. Cases of the second sort comprise two categories: those in which the inflammatory process initiated in the naso-pharynx is propagated along the Eustachian tube until it reaches the middle ear, and those in which naso-pharyngeal hypertrophies, enlarged tonsils, and adenoid vegetations produce continuous hyperæmia of the tympanic cavity either by occluding the orifice of the Eustachian tube, and so causing rarefaction of the intra-tympanic air, or by direct pressure upon the tympanic plexus of veins. Such cases, although no doubt very common, are by no means as numerous as the extremely frequent association of catarrhal otitis with catarrhal rhino-pharyngitis would lead us at first sight to suppose. The same causes that produce the latter are also efficient in producing the former, and in a great many cases where the two coexist they have been generated independently of each other and without the occurrence of any continuity of inflammation. We are not therefore to jump to the conclusion that when a patient presents himself with a chronic aural catarrh and we find a pharyngitis as well, we shall by curing the latter remove the cause of the former. In many instances, of course, this would be the case, but neither the results of treatment nor the known facts of pathology justify us in believing that in all or even in a majority of such

cases the ear-trouble has been produced by a direct extension of the pharyngeal inflammation. In making this statement it may be well to add that naso-pharyngeal catarrh, besides inducing otitis directly by extension, may also cause it indirectly either by its depressing effect upon the general vitality produced by the interference with respiration which it often causes, or by the way of reflex irritation.

In reviewing the causes of catarrhal otitis given above, it will be seen that many of them, and those, too, of the most importance, are such as are especially likely to occur among the denizens of the larger cities. Our urban population, in fact, is exposed much more than are the residents of the country districts to the bad effects of artificial climate, to the exhausting influences of overwork, hurry, and excitement, to improper hygienic surroundings, and to noise, concussion, and the inhalation of dust. Moreover, among the poorer classes, syphilitic disease and intemperance add materially to the evil effect of the very bad hygienic conditions under which they live. Hence the inhabitants of cities generally, and especially the lower classes, are good subjects for the development of catarrh. Owing to the sort of life they lead, they are usually more or less neurasthenic,—*i.e.*, have a vitality below par,—and hence the catarrhal symptoms which they exhibit are apt to have an asthenic character as compared with those found in country-people. On the other hand, those who live in the country are more likely than city-folk of the same class to suffer from the effects of improper feeding, bad drainage, and their own ignorance of the laws of hygiene. Nevertheless, the country has, in this regard, many obvious advantages over the city. Country towns and the smaller cities present conditions for the development of catarrh which are intermediate between those furnished by the large cities and the true country, but which vary greatly with the salubrity of the site and the character of the inhabitants. In small places the competition both in business and society is less severe than in the cities, and hence the conditions of life in respect to overwork and freedom from strain are more favorable; on the other hand, the enforced idleness and lack of large interests in such localities tend to produce a monotony of existence and a sluggish inactive habit which are not conducive to the proper development of the energies of mind and body, so that in people of this class we frequently find an asthenic form of catarrh. Manufacturing towns, owing to the unhealthful conditions generated by the establishments themselves and the opportunities for vice afforded by the presence of a large body of employees, have little, if any, advantage over the large cities. Another condition of existence which affords great opportunity for the development of catarrhal affections is that of the suburban resident who goes daily to his business in a large city. Here the climatic vicissitudes reach their maximum; the concussion and noise of the trains and the hurried meals and late hours incident to the daily journey are superadded to the ordinary ill effects of a city life, and the hours of rest are so curtailed that less time than usual is afforded for recreation or for exercise. These disturbing

influences are partly, but in most cases not wholly, compensated for by the stimulating and restful change from city to country life.

Frequency.—Otitis media catarrhalis chronica is an extremely frequent affection. It constitutes from one-fourth to one-third of all the cases of ear-disease met with in dispensary practice, and the proportion is probably larger than even these figures would indicate, because a moderate degree of catarrhal inflammation occurring in conjunction with other aural affections is readily overlooked, the functional disturbance that exists being attributed solely to the concomitant disease. Thus, many cases of ceruminosis are discharged as cured as soon as the cerumen has been removed, when in reality the chief cause of the deafness has all along been an aural catarrh, which, of course, persists in spite of relief afforded to what was in reality only a complicating condition.

The absolute frequency of aural catarrh, as measured by the number of cases existing in the total population, is also very great. Statistics on a large scale indicative of this proportion are not at present available, but such as have been collected show the great frequency with which in adults the middle ear is affected by disease. Steinbrügge, among one hundred soldiers whom he examined, found only eight whose drum-membranes could be regarded as normal. Similar statistics lead us to infer that in much more than the majority of grown-up people there is more or less involvement of the middle ear, and that of this majority more than half are the subjects of catarrhal otitis. It is true that among dispensary patients less than one-half (probably not more than forty per cent.) of all cases of middle-ear trouble have chronic aural catarrh; but, in consideration of the fact that the lighter cases of this affection and also the inveterate cases occurring in the very old do not come under treatment at all, it is evident that when we take the total population into account this proportion must be raised to considerably over fifty per cent.

Of course, a vast number of these cases of catarrhal trouble present very trifling symptoms. Among the one hundred soldiers that Steinbrügge examined, fully sixty-six had practically normal hearing, so that at least fifty-eight with middle-ear trouble were not seriously incapacitated thereby. And if catarrhal otitis were not a progressive disease, these slight cases might be disregarded, and we might say that while fifty or sixty per cent. of all adults suffer from catarrhal trouble, not more than fifteen or twenty per cent. require treatment. But since a slight case of otitis with very little functional disturbance and accompanied by but moderate retraction of the drum-membrane and comparatively scanty exudation and hyperæmia within the drum-cavity may very likely go on till the drum-membrane is rigid or atrophic, the chain of ossicles ankylosed, and the tympanic mucous membrane either greatly hypertrophied or completely sclerosed,—conditions incompatible with the preservation of function,—these cases cannot be disregarded, and we must assign to aural catarrh a greater frequency and hence a greater relative importance than even our statistics would indicate.

The recognition of this fact is of importance not only from a prognostic but also from a therapeutic point of view, inasmuch as our efforts at treatment are much more satisfactory when the case is still in the early stages and when no great damage of the aural mechanism nor marked impairment of function yet exists.

MORBID ANATOMY.

As has been already remarked, the pathological changes in catarrhal otitis are multiform. They may, however, all be reduced to two sets of phenomena, one comprising the various processes of proliferation, exudation, and overgrowth, the other the processes of contraction and atrophy. Inasmuch as both classes of phenomena are usually present in the same case, the processes of atrophy regularly succeeding those of hypertrophy, it is customary to describe the pathological changes as taking place in two stages,—namely, an initial stage of hypertrophy or hyperplasia, and a final stage of atrophy or sclerosis. This is a convenient division for purposes of description, and corresponds well enough to the facts in the majority of cases. We shall hence employ it here; at the same time warning the reader that there are many cases in which the phenomena of hypertrophy continue prominent throughout the whole course; that there are other cases in which from the outset the processes of shrinking and atrophy are so marked as to give them the distinguishing name of sclerotic otitis; and that, finally, there are very frequently encountered mixed cases in which either atrophy of some tympanic structures is combined with hypertrophy of others, or a hypertrophic process owing to the intercurrent of an acute inflammation is re-inaugurated in sclerotic and atrophic tissues. It is therefore more in harmony with the facts to speak of these two groups of phenomena as representing rather phases of the disease than two stages, as by using the former term we avoid the implication contained in the latter that catarrhal otitis always runs a fixed course, and that atrophy of the aural tissues always follows and never precedes hypertrophy.

The changes occurring in the mucous membranes of the drum-cavity in the *hyperplastic stage* or *phase* of catarrh are comprised under two heads: changes due to simple hyperæmia, and changes due to hyperæmia combined with proliferation. *Hyperæmia* is often inflammatory, and is then the attendant or precursor of an infiltration into the tissues due to inflammation and producing hyperplasia. But it may also be purely mechanical, being then caused either by an obstruction to the outflow of blood, as from cardiac disease, or, rarely, from pressure of pharyngeal growths upon the venous tympanic plexuses (Steinbrügge); or, more commonly, being caused by stagnation of the air in the tympanum resulting from occlusion of the Eustachian tube. In the latter case, the intra-tympanic air, originally of the same pressure as the atmosphere, is in part absorbed by the blood-vessel, and hence becomes rarefied; this removes some of the pressure from the vessels, so that the latter become surcharged with blood. This turgidity of the vessels, especially in the presence of a lessened aerial tension in the

tympanum, often leads to the exudation of serum both into the cavity of the middle ear and into the circumvenous tissue. The cavity of the drum is thus encroached upon in three ways: by the swelling of the mucous membrane due to the distention of the vessels, the swelling of the adjacent tissue from serous effusion, and the presence of a similar effusion in the cavity itself.

The changes produced by *mechanical hyperæmia* do not partake of the nature of inflammation. The exudate contains few cellular elements, does not tend to become organized, and, if the normal conditions of tension are restored, is readily absorbed, leaving the parts nearly or quite in their previous condition. The morbid change, in fact, is quite analogous to that produced by dropsy or œdema elsewhere in the body. Mechanical hyperæmia, however, although in itself non-inflammatory, frequently accompanies inflammation of the tympanum, because the latter furnishes one of the conditions for its development (occlusion of the Eustachian tube), and when thus present it tends to aggravate the symptoms due to the inflammation, and, by hindering absorption, to prevent the repair of the latter. Moreover, when existing for a long time it may produce permanent changes in the tympanic tissues by the alterations in tension that it causes; and it is not unlikely that repeated attacks of hyperæmia and œdema, although due to purely mechanical causes, may ultimately induce a condition indistinguishable from actual inflammation.

The second class of changes occurring in the hyperplastic stage or phase of catarrh are those of *inflammatory exudation* and *hyperæmia*. From the simple mechanical hyperæmia just described, inflammatory hyperæmia is distinguished by not disappearing when the mechanical causes interfering with the circulation (pressure upon the venous plexuses, occlusion of the Eustachian tube) are done away with; and from the serous transudate aspirated from the vessels in mechanical hyperæmia the inflammatory exudate is distinguished by the sluggishness with which it undergoes absorption and by its histological character. The inflammatory exudate, in fact, consists mainly of round cells which have a great tendency to increase both in numbers by proliferation and in size by a process of elongation. Owing to the latter tendency they are converted into fibrils of new connective tissue, which being arranged side by side form cords, bands, and membranes, and then constitute the organized exudates which are thus similar in essential character to the cicatricial tissue and the adhesions following suppurative processes. In catarrhal inflammation, therefore, the sub-epithelial tissue is at first reddened or bluish, swollen, and succulent from the engorgement of the vessels, the transudation of serum, and the accumulation of new round cells; afterwards, although still swollen, it acquires a firmer consistency, owing to the absorption of the serum and the multiplication and organization of the cells. The swelling may be either circumscribed or diffuse; and when diffuse, it may be much more marked in some parts of the tympanum than in others, or it may be constituted in some places

by a recent exudate, in others by one in a process of organization. Consequently, the appearances presented by the mucous membrane vary greatly. In recent cases, and where there is considerable mechanical hyperæmia associated with the inflammatory process, irregular, soft tumefactions are found, darker than the normal mucous membrane, and encroaching upon the cavity of the tympanum under the form of granular, villous, or flattened projections. The entire affected portion of the mucous membrane is relaxed and readily displaced. Later on the nodulations lose their softness and deep coloration; they get firmer and less readily movable; and their surface becomes smoother, owing to the disappearance of the granular prominences and the villousities that were produced by the excess of blood and serum. Still later, when the cells have all undergone organization, the mucous membrane, while still a good deal thickened, becomes paler than normal, and quite smooth, hard, and rigid, so that it can be displaced only with difficulty upon the underlying structures. It has, in fact, been converted into firm, fully-formed connective tissue. This condition represents a state intermediate between the stage of hypertrophy and the stage of atrophy and sclerosis.

The *sclerotic* or *atrophic* stage or phase of catarrh is in most cases dependent upon a continuation of the process just described. The connective-tissue fibrils formed out of the elongated round cells of the sub-epithelial exudate begin to undergo a progressive contraction. They grow shorter, thinner, and more consistent. Hence the exudate, which is mainly composed of these fibrils, also shrinks in size and becomes hard and rigid. This process of shrinking and hardening (sclerosis) continues until the mucous membrane from being several times its usual thickness becomes even thinner than normal. Moreover, it is no longer pliable and elastic, but stiff, hard, and tightly stretched from point to point of the tympanum. To this sclerotic process is superadded one of atrophy induced by the pressure that the shrinking connective tissue exerts upon the vessels and secreting cells of the membrane. Hence the blood-supply of the affected part is gradually cut off, the secretion is arrested, and the membrane becomes anæmic, colorless, and dry. The interference with nutrition may be so great that the new-formed connective tissue also may atrophy or become degenerated, and in this way sometimes actual gaps or fissures are formed. The formation of such gaps is facilitated by the state of tension produced by the shrinking of the fibres; for the fibres that are thus put upon the stretch, on the one hand, tend to rupture when degenerated, and, on the other hand, if intact, tend to pull asunder the structures to which they are attached. Another consequence of the degenerative processes induced by the interference with the nutrition is the deposition of calcareous salts. This occurs particularly in the deepest layers of the membrane close to the bone surfaces and in the ligaments and cartilages connected with the ossicles, and also in the membrana tympani and the membrane in the fenestra rotunda. These deposits necessarily cause marked rigidity of the parts,

and, in the ossicular joints, bony ankylosis. They appear under the form of whitish concretions of various sizes and shapes. When the sclerotic process affects the periosteum, hyperostoses may be produced projecting into the tympanic cavity. The formation of these calcareous and osseous deposits is probably accounted for by the fact that the sclerotic processes are most prominently developed in the deep layers of the submucous membrane close to the periosteum.

As a consequence, then, of the atrophic processes, the cavities affected become more roomy than normal, and are lined by a pale, thin, tense, rigid, and non-secreting membrane which in spots is sometimes almost entirely deficient, and elsewhere is studded with calcareous deposits.

As before remarked, the processes of hypertrophy and atrophy are frequently associated; and it is quite common to see islands of white, depressed fibrous tissue in the midst of the red, succulent overgrowths produced by engorgement and exudation. In such a case we have evidently side by side the first and last stages of the same process,—a process which in its essential feature is quite analogous to cirrhosis or fibroid inflammation of the liver, kidney, and lungs, sclerosis of the brain and spinal cord, and trachoma of the eyelids.

Sclerosis, however, here as elsewhere, is not always preceded by an evident stage of hypertrophy. Cases of this sort in which from the very beginning the inflammation takes on the atrophic and sclerotic form are characterized by their insidious course, the absence of objective signs (slight involvement of the *membrana tympani*), and the profound functional disturbance that they ultimately produce. This variety of inflammation shows a special tendency to affect the inner wall of the tympanum, producing, in addition to a very characteristic chronic hyperæmia of the mucous membrane of the promontory, hyperostosis of the foot-plate of the stapes, bony ankylosis of the stapedio-vestibular joint, and sclerotic fixation of all the parts about the fenestra ovalis. The incudo-malleal joint also is often frequently ankylosed. In fact, in sclerosing inflammation the most prominent feature is the involvement of the periosteal, cartilaginous, and ligamentous structures of the roof and inner wall of the atrium; and, according to some, it is this region that forms the starting-point of the process. The causes that predispose to the production of this peculiar variety of catarrhal inflammation, which, as will be observed, predominantly affects the deeper structures of the tympanum, are not known.

Such in general are the changes produced by catarrhal inflammation in the tympanic cavity. It now remains to consider their effects upon the transmitting mechanism of the ear and upon the labyrinth.

The *membrana tympani* usually participates to a greater or less extent in the inflammations of the drum-cavity. The changes produced in it are hyperæmia, retraction, thickening, and atrophy.

Hyperæmia of the drum-membrane is frequent, being usually found in conjunction with subacute catarrh or acute exacerbations of chronic

catarrh. When present it is especially marked in the vessels along the handle of the malleus.

Retraction of the membrana tympani occurs in hyperæmia and hypertrophic catarrh of the drum-cavity, being then caused by the pressure of the external atmosphere which is not sufficiently compensated for by the pressure of the rarefied intra-tympanic air. Since the stagnation and consequently the rarefaction of the latter are due to the occlusion of the Eustachian tube, the retraction is relieved by anything which overcomes this occlusion. Hence this condition, which may be denominated functional retraction, is often markedly benefited by Politzerization or catheterization; although it must be allowed that, as the occlusion tends to recur, the benefit is very frequently not permanent. Functional retraction, although not due to organic changes in the membrane, may, if long continued, set up organic changes in the latter, such as, for example, atrophy dependent upon the stretching of the fibres; and it may also cause serious derangement in the function of the ossicles through the alterations in their tension that it produces. Still more harmful is the organic retraction of the drum-membrane caused by the organization and shrinking of the exudates. The retraction in this case may be either *primary*, i.e., be a state of true contraction and rigidity, produced by a shrinking exudate situated in the membrana tympani itself, or *secondary*, due to the drawing in of the chain of bones by sclerotic processes going on in the attachments of the latter. This sort of retraction, being structural in its character, is but little likely to be affected by the propulsion of air into the tympanum, and hence we find that Politzerization in these cases is of little avail. The retraction may be so extreme that the drum-head is carried inward as far as the inner wall of the tympanum; and in that case it may be immovably attached to the latter by adhesions of new-formed connective tissue.

Thickening of the drum-membrane is a very common feature of aural catarrh. It is produced by the same processes of hypertrophy that take place in the rest of the tissues lining the tympanic cavity. The hyperplasia starts in the mucous layer of the membrane and usually extends into the membrana propria of the latter. It is frequently diffuse, involving the whole drum-membrane; at other times it is circumscribed. Quite often it is accompanied by sclerosis, so that the membrane is at once thickened from the excess of material exuded, and contracted and rigid from the shrinking and hardening of some of the new-made tissue.

Atrophy of the drum-membrane is less frequent. It is due either to a failure of nutrition caused by the sclerotic shrinking, or more frequently, perhaps, to the stretching of the fibres produced by long-continued retraction. It is restricted to the membrana propria, or, at least, is most pronounced there, and, like the converse process of thickening, may be diffused over the whole drum-membrane or may be localized in spots. In rare cases it predisposes the membrana tympani to rupture from slight causes, and even without the intervention of the latter may lead spontaneously to per-

forations of the membrane which may be hard to diagnosticate from those produced by suppuration. Atrophy may also be associated with the formation of calcareous deposits in the drum-membrane.

The *membrana tympani* may be either more tense than usual or may be unduly flaccid; the alteration in tension being the natural consequence of the changes—viz., retraction, thickening, and atrophy—just enumerated.

The changes in the *membrana tympani* do not necessarily, by any means, keep pace with those existing in the drum-cavity. A greatly thickened and retracted membrane may be found with but moderate evidences of inflammation of the tympanic structures; and, on the other hand, cases of insidious sclerosis, even when productive of ossicular rigidity and ankylosis of the joints, are commonly unattended by any marked changes in the membrane.

The *ossicles* in catarrhal otitis are subject to numerous pathological changes. Even when they are not obviously involved themselves, their motion is interfered with by the retraction of the drum-membrane and the swelling of the parts about them. But the inflammatory process very commonly extends to them, affecting their periosteum, their articular surfaces, and the ligaments and other structures connected with them. In the sclerotic phase of inflammation, calcification and even ossification of the parts adjoining the bones are frequent. Hence we find both fibrous and bony ankylosis of the various joints and rigidity of the ligaments and membranes that assist in composing the sound-conducting mechanism.

The *tensor tympani* is sometimes found contracted, owing to long-continued retraction of the *membrana tympani* or to shrinking of the connective-tissue sheath of the tendon of the muscle.

The *Eustachian tube* usually shows changes in its mucous membrane similar to those found in the mucous membrane of the tympanum. In the hyperæmic and hyperplastic stage of catarrh the Eustachian tube is often more or less narrowed or even quite occluded; and this occlusion, as we have seen, is an important factor in maintaining and aggravating the catarrhal trouble. But in many cases, especially when the catarrhal process has passed into the atrophic phase, the tube, so far from being contracted, is unduly patulous. In this condition the employment of Politzerization, indicated when occlusion exists, is useless, and may be even harmful.

The *labyrinth* is more or less implicated in most prolonged cases of catarrhal otitis, and particularly in those forms in which the sclerotic processes are marked from the beginning. These labyrinthine changes, the nature of which is but little understood, are referable partly to the alterations of the pressure within the labyrinth, partly to the direct transmission of inflammation from the tympanum. The alterations of intra-labyrinthine pressure may be negative, being then consequent upon rarefaction of the air within the tympanum, or positive, as when the chain of bones is driven inward by sclerotic processes and the retraction of the drum-membrane.

The transmission of inflammation to the labyrinth from the middle ear doubtless takes place mainly by way of the fenestra ovalis. That it does actually occur is shown by the fact that thickening and calcification of the lining membrane of the vestibule have been found in conjunction with catarrhal otitis (Steinbrügge). Atrophy and fatty degeneration of the labyrinth are also, as Politzer has pointed out, of frequent occurrence in these cases. The latter author considers many of these cases of labyrinthine affection not as secondary to the tympanic disease, but as developed coincidentally with it from the operation of the same exciting cause, and in certain cases he regards the inflammation of the labyrinth as primary and that of the middle ear as secondary, being produced by transmission of the inflammatory process from the vestibule.

The *external auditory canal* is often found to be abnormal in catarrhal otitis. In a number of cases too large to be explained as mere coincidences, the author has found an unusually wide canal in connection with this disease. He has sometimes been inclined to consider this undue patulousness of the canal in the light of a causal factor in the production of otitis, the membrana tympani in these cases being insufficiently shielded from injurious influences. On the other hand, this condition may be looked upon as an expression of the same pathological state that exists in the middle ear; it may be, in other words, the result of the same atrophic processes that take place in the tympanum.

SYMPTOMS.

The chief symptoms of catarrhal otitis are impairment of function (deafness), perversion of function (anomalies of audition, subjective auditory disturbances, tinnitus), and vertigo.

Deafness in middle-ear catarrh presents all variations from slight impairment to almost absolute abolition of hearing. It is progressive, although its progress may be so slow that the patient may not be aware that any increase of deafness is taking place. In such cases often some slight exacerbation of the symptoms due to a fresh cold, by making the hardness of hearing a little more noticeable, calls the patient's attention to the fact that he is deaf. Being thus suddenly made aware that he does not hear as well as he used to do, he is apt to charge the whole attack to the account of the exciting cause then present, and yet when we examine the ear we find abundant evidence that the disease has already been in existence for a long time. And in all cases in which the deafness appears to be suddenly initiated or discontinuous, it is probable that if we could have the patients under continuous observation the impairment of hearing would be found to be really more or less progressive.

Deafness due to catarrhal otitis increases markedly as old age comes on, and this for three reasons: 1st, because the disease itself becomes more and more inveterate and tends to go over into the sclerotic stage, in which the changes produced are persistent and do not undergo retrogression either spontaneously or from treatment; 2d, because the liability to involvement

of the internal ear¹ increases when the tympanic inflammation has lasted a long time, and particularly when, owing to sclerosis of the conducting mechanism, it has caused long-continued elevation of the labyrinthine pressure; 3d, because a natural senile atrophy of the drum-membrane and tympanic tissues is superadded to the inflammatory process, and not only aggravates the symptoms of the latter, but also favors the conversion of a hypertrophic process into one of sclerosis.

The rapidity with which the deafness increases shows very great variations. Some who have doubtless had a catarrhal otitis media from their childhood nevertheless retain a serviceable degree of hearing during their whole life. In others deafness sets in early and advances rapidly, so that by the age of twenty, or even earlier, they can no longer hear ordinary conversation. This early and marked impairment of hearing, although very frequently caused simply by the rapid progress of the ordinary catarrhal processes in the middle ear alone, may be dependent upon an early (perhaps primary) involvement of the labyrinth or upon the insidious sclerotic process that especially affects the inner wall of the tympanum. Inasmuch as neither of these conditions is ordinarily associated with much change in the membrana tympani, and inasmuch as we often find considerable thickening and retraction of the latter along with quite a fair degree of hearing-power, it is obvious that the amount of deafness present is by no means indicated by the pathological alterations visible upon an objective examination of the ear.

The extreme degrees of deafness, especially if rather suddenly developed, as during the invasion of syphilis, and absolute deafness in any case, are probably often indicative of an affection of the labyrinth.

Moderate degrees of deafness are usually referable to the alterations in the middle ear interfering with sound-conduction. Altered tension, retraction, and rigidity of the drum-membrane, displacement and fixation of the chain of ossicles, contraction of the lumen of the tympanic cavity, and diminution of the pressure of the air contained in it, are some of the conditions existing in this disease by which the transmission of sound-waves may be interfered with. Usually it is not possible to tell just to what pathological condition the functional disturbance is due. Nevertheless, we must attempt wherever we can to distinguish between the deafness caused by the exudative and hyperæmic processes and that due to sclerosis, since this distinction is of importance with regard to prognosis and treatment. Hearing-power that has been reduced by swelling and engorgement of the mucous membrane and by occlusion of the Eustachian tube is often temporarily increased by Politzerization or catheterization, while a deafness due to sclerosing catarrh is apt to be but little affected by these manœuvres even for

¹ This factor, however, has not, in the author's experience, the force that has been attributed to it. He is inclined to think that extensive involvement of the internal ear is less common (even in the aged) than is generally supposed. This seems to be proved by the beneficial results of radical treatment in such cases.

the time being. Hence, if we can increase the hearing-power by these means, we are led to infer that the former condition, which is much more amenable to treatment, is responsible for the functional trouble. Again, the presence of marked fluctuations in the hearing-power, occurring from day to day and often sudden in development, is an indication that the deafness is mainly due to hyperæmic and exudative swelling of the mucous membrane of the tympanum and Eustachian tube. Such fluctuations are apt to be determined by changes in the weather, mental and physical depression (especially apt to occur in the subjects of catarrh), exhaustion and fatigue, undue excitement, —in a word, by the same agents whose repeated action has already served to set up the catarrhal state. If the access of deafness due to any of these causes is found to be temporary only, or to be relievable by removal of the cause, the probability of hyperæmia and exudation being at the bottom of all the hardness of hearing that exists is greatly strengthened. For, while swelling of the mucous membrane and consequent temporary increase of deafness may take place during the stage of sclerosis, it is much less likely to do so than in the hypertrophic stage, when the parts are still vascular. Hence we may say that marked temporary variation in the acuteness of hearing, whether produced spontaneously or by treatment, justifies us in assuming that the whole functional disturbance present is caused by the congestion and hypertrophy and not by the sclerosis of the tympanic tissues.

Hearing may be diminished to the same degree for all sonorous impulses. Frequently, however, this is not the case. A patient may have comparatively good audition as measured by the watch or acoumeter, and yet hear whispered and spoken voice very indistinctly. Again, a man who hears vocal sounds well enough for all practical purposes may scarcely hear the watch at all. And, finally, one who has good auditory power for both watch and voice may have impaired perception of musical sounds. The practical point is that in nearly all cases the degree of perception of ordinary voice measures the usefulness of an ear for hearing, and that therefore the facility with which speech is transmitted by the diseased tympanum is the chief test in determining both the amount of impairment of the latter and the success of our treatment. Nevertheless, it is well also to determine the audibility of sounds of all sorts, since some diagnostic importance has been attached to differences in this regard. Thus, Lucae points out that comparatively good hearing for the watch and acoumeter associated with very defective hearing for the voice is an evidence of the existence of sclerotic processes upon the inner wall of the drum-cavity.¹

¹ Politzer thinks that the reason for this is that, while simple tones can be transmitted without the aid of the ossicles, the integrity of the latter is an essential condition for the conveyance of a series of complex tones, such as those of which speech is composed. This view, however, is negatived by the fact that the hearing-distance for speech is often considerably increased by removal of the ossicles; hence immobility of the latter would seem not only to render them useless for the transmission of sound, but also to cause them to be absolute obstructions to the conduction of sound by other channels.

Peculiar modifications of the hearing are quite frequent in catarrhal otitis. They comprise—

1. *Dysacusma* or *dysæsthesia acustica*,—*i.e.*, a sensation of pain or discomfort caused by loud or even moderate noises. This may coexist with a considerable degree of deafness. It should not be confounded with *hyperæsthesia acustica*, a condition which, if it exists at all, signifies excessive sensitiveness of the centres of hearing, marked by such an abnormal acuity of auditory perception as enables the patient to appreciate sounds inaudible to others.

2. *Pseudacusma* or false hearing, in which outside sounds or the sound of one's own voice are heard altered in pitch and quality. Several interesting instances of this have occurred in the author's practice. Naturally those who can most readily appreciate this defect—*i.e.*, those who have had a regular musical training—suffer the most from it; and it is in this class that such cases are most frequently met with. In some instances among singers or musicians it constitutes a serious impediment to the practice of their profession.

3. *Autophony*, a condition very analogous to the preceding, in which the sound of one's own voice, often altered in quality, is heard either as if coming through the tissues of the head or as if emanating from some outside source. It was present in about twelve per cent. of the author's cases. The reverberation of these sounds in the head and the apparent changes in pitch, timbre, and intensity often render them most distressing to the patient. A similar reverberation and alteration in character take place in sounds emitted in close proximity to the body, as those produced by a violin upon which the patient is performing; the notes then seeming to pass up to the inner ear through the tissues of the head instead of through the normal passages. Certain varieties of tinnitus, which are produced by the magnification of sounds actually existing in the head (*e.g.*, those caused by the motion of the blood in the vessels, by the movement of the jaw in mastication and of the throat in deglutition, and by the rattling of the drum-head and ossicles), are also in reality examples of autophony.

4. *Paracusis duplicata* or *diplacusis*, a very rare condition, in which sounds are doubled so as to be heard twice in the same ear. In certain cases of autophony the voice resounds so in the tympanic cavity that it forms a sort of echo of itself and so simulates a diplacusis.

5. *Paracusis Willisii*, or increased hearing-power in the midst of a noise. The very existence of this symptom has been contested by some, but that it does occur has been proved by tests the validity of which in the hands of competent observers cannot well be questioned. The author himself has met with a great number of such cases. The presence of paracusis Willisii has been regarded as of evil prognostic significance, since it has been held to occur much more frequently in the advanced, irremediable cases of sclerosis in which there is marked fixation of the ossicles; but this view of the case does not accord with the author's experience, in which this

peculiar disturbance was found to exist in cases the prognosis of which, as the event proved, was by no means bad.

After deafness the next most important symptom is *tinnitus*. Indeed, in many cases it takes the first rank among the symptoms, being the chief and perhaps the only complaint that the patient has to make. It is a matter of common observation that for the ordinary purposes of life people can get along with a much smaller degree of auditory power than that which is regarded as the normal standard, so that many whose hearing-distance is shown by our tests to be considerably reduced do not think that they are deaf or that they require medical treatment. Moreover, the absence of hearing, being a mere negative symptom, is not appreciated as quickly by the patient himself as by those about him who by reason of it are compelled to raise their voices in speaking to him. Hence in a gradual, progressive deafness, such as is induced by catarrhal otitis, it is quite often the case that the patient is first made aware of his infirmity by the statements of his friends. But a positive subjective symptom like tinnitus engages the patient's attention as soon as it becomes at all prominent, and if unusually marked it is sure to occasion him great annoyance and distress. If still more intense, the disagreeable sensations that it produces may amount to actual pain; and very aggravated cases in which the subjective sounds are very loud or almost constant make the patient's life a real burden to him and not infrequently unfit him for all enjoyment of life or for any continuous work. Such patients are apt to become melancholic; and it is likely that some cases of insanity are attributable to this cause.

Tinnitus is a very frequent accompaniment of middle-ear catarrh. It was present in a marked degree in twenty-five per cent. of the cases examined by the author. If the cases of slight or occasional tinnitus had been included in this estimate, the proportion would, of course, have been much larger. Like the symptom of deafness, it tends to increase in intensity with the course of the disease, being therefore most pronounced in the sclerotic stage. But as, unlike deafness, it is mainly due to adventitious and extra-tympanic causes, it is usually discontinuous and is very greatly influenced even in the sclerotic stage by outside conditions. Hence in all stages of catarrhal otitis the tinnitus shows great fluctuations both in intensity and constancy. Involvement of the labyrinth, which causes great and often sudden increase in the deafness, may produce either increase or decrease in the tinnitus, according as the auditory nerve fibres are simply irritated or are rendered functionally incompetent. Accordingly, the permanent abolition of tinnitus in an advanced case of aural catarrh points strongly to grave involvement of the internal ear.

Tinnitus varies not only in intensity and constancy, but also in quality, pitch, and rhythm; and these variations comprise the widest possible range. Indeed, there is scarcely a known sound the counterpart of which has not been at some time heard as a subjective noise in the ear. Of course, fancy plays a large part in the description by the patient of these subjective phe-

nomena, and, moreover, it will usually be found that he likens the noises in his ear to external sounds with which he is familiar. Thus, the mechanic thinks he hears the sound of escaping steam or the din of machinery, and the farmer may say that he hears the buzzing of bees or the humming of flies. Again, in hysterical and nervous patients, always prone to magnify their sufferings, the imagination comes so greatly into play as to render their accounts of the character of the noises quite worthless. Hence, in a case like this, where we are entirely dependent upon the good faith and the descriptive ability of the patient, we must not accept the statements that he makes too unreservedly nor consider them as an altogether safe guide in diagnosis. Nevertheless, it would be equally wrong to reject these statements entirely, for in many instances they furnish useful hints as to the causation of the tinnitus and the probable pathological condition existing. Thus, a pulsating, beating, or pumping sound, especially if recurring in regular synchronism with the movements of the heart, is referable to vibrations set up by the passage of blood through the vessels and transmitted to the internal ear either through the ordinary channel or through the tissues of the head. These vascular sounds are much increased by stooping, by physical exertion, or by mental excitement,—in a word, by any cause intensifying the circulation in the vessels of the head and neck. As before pointed out, they often really constitute a variety of autophony. Again, other sounds may be recognized as synchronous with the movements of respiration, of mastication, or of deglutition. These sounds, as well as those of vascular origin, have their source outside of the ear, and their appreciation by the latter must be due either to increased sensitiveness of the auditory apparatus (a sort of hyperalgesia acustica), or, much more likely, to changes in tension in the sound-transmitting apparatus, which by interfering with the aerial conduction of sound at the same time facilitate the conduction of vibrations through the tissues of the head. Certain other species of tinnitus, likewise autophonous in character, are produced by sounds generated within the ear itself. Such sounds may be occasioned by the movements of the ossicles, in which case the noises are apt to have a metallic character and to be described as ticking or grating, or they may be due to agitation of the dry drum-membrane, and are then spoken of as crackling or crumpling, or they may be the result of the sudden separation of agglutinated mucous surfaces, when the patient says that he has a sensation of opening and shutting in the ear. Lastly, tinnitus may be the consequence of changes in the sound-perceiving apparatus, in which case there will be usually some other evidences of labyrinthine involvement.

Just as in some cases the hearing becomes better in the midst of a noise, so also there are instances of tinnitus, which, usually constant and distressing, is rendered much less marked or even disappears altogether when the patient is surrounded by noises or is subjected to repeated concussions. Thus, in many of the author's cases a very annoying tinnitus ceased whenever the patient travelled on the railroad-cars or walked out upon a crowded street.

In these cases the improvement in the subjective sounds was associated with an improvement of the hearing under the same conditions (paracusis Willisii), and it is not unlikely that the two conditions have a similar origin and significance.

Patients frequently complain that the tinnitus is more annoying at night, this being due either to the fact that their attention is more readily called to it then when everything is quiet and there is nothing to distract their mind, or being due to the increased congestion of the head caused by the recumbent posture.

Tinnitus, like deafness, is especially marked in advanced life, when the natural senile changes occurring in the drum and drum-membrane interfere with sound-conduction and aggravate any catarrhal state that may be present. In women it is apt to become particularly prominent about the time of the menopause.

Auditory hallucinations, such as occur now and then in aural catarrh, may, in most cases, be regarded as a sort of tinnitus modified for the patient's mind by the peculiar interpretation which his psychical state leads him to give to them. That is, they probably take their origin in most, if not in all, cases, from actual sounds generated in or about the ear; sounds which, unimportant in themselves, are altered by the patient's imagination and magnified into matters of great significance. Thus, the noise of the blood pulsating in the vessels or the crackling of a dry and atrophic drum-membrane may, to an imaginative and nervous person, be transmuted into the voices of dead friends or some other supernatural sound. And as the imagination is apt to be most powerfully impressed at night, when also the tinnitus is usually most pronounced, the supposed voices and other hallucinations are generally heard at this time, while during the day the patient may not be troubled by them. The importance of these hallucinations, apart from the distress that they cause the patient, lies in the fact that in persons predisposed to insanity they may actually induce the latter or, at least, may assist powerfully in its production. Severe and constant tinnitus alone may do this in extreme cases; but tinnitus is much more apt to do so if the mind of the patient is already so far diseased that it has come to regard these subjective sounds as veritable objective realities.

The third great symptom of catarrhal otitis, and one of which the patients often complain more than of all the others put together, is *vertigo*. It was present in eight per cent. of the cases examined by the author. Like the other symptoms, it displays great variations as regards both the frequency and the severity with which it occurs. In some cases limited to transient attacks of giddiness, it becomes so pronounced in others that the patient can no longer maintain his balance, and, unless supported, falls to the ground. Such extreme cases as the latter are not so very infrequent. They include a number of the cases formerly grouped under the head of Ménière's disease; it now being recognized that pronounced vertiginous attacks and disturbances of equilibrium associated with marked deafness are not necessarily dependent

upon a primary involvement of the labyrinth, but may be caused by a catarrh of the middle ear. Of course, even in the latter case, the labyrinth is the region that is immediately responsible for the production of the vertigo, which is due either to absolute structural changes transmitted to the internal ear from the tympanum, or to simple alteration of intra-labyrinthine pressure occasioned by an increased tension of the transmitting mechanism and particularly by the impingement of the chain of ossicles against the fenestra ovalis. The difference between these two varieties of vertigo—namely, between the kind due to primary or secondary structural change in the labyrinth, and the kind that results from alterations in pressure induced by outside influences—is of great practical importance. For, while cases of the first sort are evidently irremediable, cases of the second variety hold out some prospect of relief. And, as a matter of fact, in not a few instances removal of the exciting cause—*i.e.*, of rigid and ankylosed ossicles—has, in the author's experience, completely abrogated the vertigo. It becomes, therefore, very important with reference to prognosis and treatment to be able to separate the cases of structural from those of functional involvement of the inner ear. This discrimination is often difficult, sometimes impossible. It will receive detailed consideration under the head of diagnosis. It need only be added here that vertigo occurring in conjunction with catarrhal otitis may be due to intercurrent cerebral disease, and that this possibility must not be lost sight of when we are determining our diagnosis, prognosis, and treatment.

Vertigo is usually a discontinuous symptom. Even when more or less constantly present it is subject to very great fluctuations in intensity. In general it is aggravated by the same extraneous conditions that render tinnitus more pronounced,—*i.e.*, by those which increase the intra-cranial circulation (physical exertion, straining, stooping, mental excitement, etc.).

Sensations of discomfort in the head or ears, variously described as feelings of weight, pressure, or fulness, are not uncommon accompaniments of aural catarrh. They are partly referable to the changes in the ear, partly to associated alterations in the throat and nose interfering with respiration.

Pain in the ear (*otalgia*) was present in two per cent., and *neuralgic pains* in other localities were present in five per cent., of the cases examined by the author. In a certain number of these cases the pain may have been a mere intercurrent symptom, in others it is possible that the catarrh was responsible for the neuralgia. A connection of cause and effect is not improbable, especially in the sclerotic stage, when the tissue, as it shrinks, squeezes the nerve-fibres, and may thus excite an irritation which finds expression under the form of pain referred either to the parts immediately adjacent (*otalgia*) or to remoter regions (*neuralgia*). On the whole, however, catarrhal otitis is a painless disease, and even when present the pain is apt to be quite a subordinate feature.

In addition to the symptoms already named, which may all be regarded as purely local in character, certain *general symptoms* are not infrequently

met with in conjunction with catarrhal otitis. These consist mainly of the symptoms of the disease or systemic condition exciting the catarrh. Thus, in children who are the subjects of catarrh we often find the pale, bloated, and sodden skin indicative of chronic malnutrition dependent either upon disease or upon improper hygiene; and in adults we often discover evidences of nervous exhaustion, such as excitability and irritability of temper, a tendency to become tired in mind or body upon comparatively slight exertion, a predisposition to migraine and neuralgia, etc. In regard to these symptoms of nervous depression, however, it must be said that it is not always easy to discriminate between those that are due to the condition causing the otitis and those that are the direct result of the latter itself. For long-continued catarrh, whether diffuse or localized, is itself a depressing agent, and often a very powerful one. Catarrhal otitis in particular is apt to engender a neuropathic state or aggravate one already existing. All the symptoms contribute more or less to bring about this result. Marked deafness by shutting off a man from many social enjoyments and secluding him from companionship with his fellows, tinnitus and vertigo by the distress, the confusion of mind, and the anxiety which they occasion, produce a condition of general nervous depression which, in time, reacts upon the general health. Indeed, in advanced cases in which all three symptoms have attained a high degree, it is not uncommon to find the patient in a state bordering upon melancholia, or affected with such a marked reduction of the body-weight and the vital forces as indicates a profound impairment of nutrition. That these evidences of physical and mental disorder are symptomatic, at least in some instances, of a lesion which is the result of the aural condition and not the cause of it, is proved by their disappearance when the latter is relieved. The author has several times had the opportunity of observing cases in which improvement of this sort was quite striking. For instance, after excision of the ossicles undertaken especially for the relief of marked tinnitus and vertigo, a decided gain in the body-weight, an improvement in the nutrition generally, and a great increase in cheerfulness and mental alertness are not infrequently met with.

We may *summarize* the symptoms of catarrhal otitis as follows. The three main symptoms are deafness, tinnitus, and vertigo. Of these deafness is the one most constantly present and usually also the most prominent, although cases in which tinnitus or vertigo is chiefly complained of are quite frequent. Deafness is almost always progressive and usually shows a very gradual increase, the course, however, being often marked by exacerbations which are transient when due to intra-tympanic hyperæmia and permanent when caused by involvement of the labyrinth. Tinnitus is usually discontinuous, sometimes continuous, and is subject to sudden variations which can be generally traced to alterations in the cerebral circulation. Vertigo is even more inconstant in its presence than tinnitus, and is subject to variations of the same sort and due to the same causes; and in origin it is either the result of irremediable changes in the labyrinth or of functional alterations

of pressure set up by the middle-ear catarrh. Minor symptoms of aural catarrh, which, however, in some cases become of considerable importance, are the various anomalies of audition (autophony, dysacusma, paracusis Willisii), auditory hallucinations, otalgia, neuralgia, and the evidences of constitutional depression.

OBJECTIVE SIGNS AND DIAGNOSIS.

The diagnosis of middle-ear catarrh is in general effected by three procedures: 1. Testing of the function (determination of the hearing-distance and of bone-conduction). 2. Inspection of the canal and membrana tympani. 3. Artificial alteration of the conditions of tympanic pressure (Politzerization, catheterization).

Functional testing demands, in the first place, the careful determination of the *hearing-distance*. This should be done in the usual way for each ear separately, and the result expressed in a fraction whose numerator is the hearing-distance found and whose denominator is the normal hearing-distance of the sound employed. The hearing should be tested by the voice and by the watch or some other similar instrument. Of these tests that with the voice is practically the most important, since it furnishes the best measure for the usefulness of the hearing, and with suitable precautions can be made as accurate as the others. It is well to use both the whisper and the ordinary conversational tone in routine examinations, reserving loud conversation or shouting for the very deaf. Care, of course, should be taken that there is no possibility of lip-reading on the part of the patient, and that the test-words should be unfamiliar to the patient or at least formed into unexpected combinations, so that there can be no room for supposing that he is guessing instead of actually hearing the words. Again, the voice must be regulated so as to have the same pitch and intensity at successive examinations,—a matter not difficult to acquire with practice,—and, as in all the tests of hearing, the surrounding conditions must be at least approximately the same at the different times of testing. Of the other hearing-tests the watch has the advantage over such means as the acoumeter, that it furnishes a much weaker sound, and hence is a more delicate measure of the lighter degrees of deafness. The acoumeter, on the other hand, has the advantage that, all acoumeters being made alike, it allows of the results of one observer being compared with those of another. In addition, the fact that its tick can be set going or arrested at will enables us to check the patient's statements and determine whether he actually hears the sound or not; for if at any distance he invariably alleges that he begins to hear the acoumeter at the moment we start it, and that he ceases to hear it the instant that we stop it, we can be sure that for this distance his statements are accurate. The same result can be attained with a stop-watch, and, in the author's opinion, the watch is, in any case, a much more practical and available test than the acoumeter, and quite as accurate. Any observer's watch, when its intensity has been determined by trial upon a number of normal

ears, furnishes exact measurements which are always comparable with those obtained by any other instrument or by any other observer.

For determining the sensitiveness of audition for sounds of varying pitch, the tuning-fork and König's rods may be employed; the latter being especially useful in ascertaining the highest note that the ear can appreciate as a sound. Researches with these instruments are interesting, but the results obtained with them have not so far been sufficiently accordant to afford us much that is of practical value in diagnosis. It has been supposed that inability to hear the higher numbers of König's rods is indicative of labyrinthine trouble or, at least, of some serious involvement of the ear. But cases have come under the author's observation which by no means accord with this view. Thus, in one instance in which the hearing was extremely acute and no evidence of trouble was present, the highest tone audible was that emitted by a König's rod vibrating twenty thousand per second, while the normal ear is supposed to hear one vibrating twice as fast.

Tuning-forks of varying pitch have been employed, with the idea of ascertaining the relative audibility of the higher and lower tones. Musical instruments may obviously be used for the same purpose. In some cases it will thus be found that certain notes of the scale are heard with much less intensity than others; and this has been thought to indicate some defect of Corti's organ. But this view is based mainly upon theoretical reasoning and not upon pathological evidence; and even if such a condition exists it is not unlikely a congenital state, and thus of scientific interest rather than of practical importance.

A more useful application of the tuning-fork is in determining the *bone-conduction*, or, as it should rather be called, the *tissue-conduction*, since other tissues than bones take part in the transmission of vibrations through the head. As has been shown before, it is of prime importance for the purposes of prognosis and treatment to ascertain whether the functional impairment that exists in a case of aural catarrh is due entirely to the condition of the middle ear, or whether the labyrinth is not also irreparably involved. In the latter case the outlook is, of course, much more serious than in the former. Now, it is well known that, speaking broadly, whenever the transmission of sounds through the natural channel (by aerial conduction) has been interfered with, conduction through the tissues of the head is increased, so that an ear whose sensitiveness to sound is dulled, simply because the rigid membrane and ossicles no longer carry the aerial vibrations with the same efficiency as formerly, will hear a tuning-fork placed upon the vertex even better than the other, normal ear. And when consequently an ear deaf from middle-ear disease does not hear the tuning-fork on the vertex as well as the other ear does, impairment of the labyrinth is held to exist; for if the labyrinth were intact, the actual capability for the perception of sound would not be altered, and, as interference with aerial conduction only serves to make tissue-conduction more pronounced, the

tuning-fork would be better heard. Hence this test is regarded as a very important one, and examining in a case of catarrhal otitis we always make it, placing the vibrating fork upon the vertex or glabella and asking the patient in which ear he hears the sound. If it is certain he hears it better in the affected ear, we may exclude any great lesion of the sound-perceiving apparatus. Unfortunately, we cannot be equally positive in asserting the converse to this proposition,—namely, that if the sound is heard worse in one ear or even is not heard there at all, there is certainly trouble with the internal ear on that side. For in the first place we are dependent for our information solely upon the statements of the patient, who is quite likely to lead us astray. Many patients cannot tell which ear they really hear the fork better in, and then are apt to say that they hear it with the better ear, simply because they think that this is what is expected of them, or because they imagine that their own sensations must be at fault. But apart from this conscious or unconscious deception, the tuning-fork test fails altogether with many patients. Even in normal ears the tissue-conduction varies a good deal, and some people do not hear the tuning-fork at all when it is placed upon the vertex. A further source of error lies in the fact that we are not always able to say that the ear with which comparison is made is actually normal, or even that it is better than the other. For the external evidences of a profound involvement of the tympanum may be very slight, so that we might be led to regard as normal an ear in which there was a good deal of obstruction to aerial conduction and consequently an abnormally increased tissue-conduction. In such a case the tissue-conduction for the other ear, although really increased, might be thought to be below the normal because less than on the side which to all appearances is but slightly affected. Moreover, we cannot always be certain whether the patient actually hears the tuning-fork or simply feels the jar of its vibrations transmitted through the head. This is especially the case when the fork is placed upon the teeth. In this situation the tuning-fork is frequently heard most readily; indeed, it is sometimes heard here when it is audible nowhere else upon the head; but, unfortunately, the mechanical effect of the vibrations is also greatly enhanced, and what appears to the patient to be a sound may be simply a series of concussions carried up through the head from the teeth. In spite, however, of all these uncertainties, we may say that if aerial conduction and tissue-conduction are both markedly diminished on the same side there is at least strong presumptive evidence of a lesion of the internal ear. There is still, of course, left the uncertainty whether the lesion is functional or structural, temporary or permanent; and this uncertainty can be resolved only by the consideration of the other symptoms.

A method of testing the tissue-conduction in which comparison with the other ear is avoided is Rinne's test. This consists in comparing the duration of the auditory impressions conveyed by tissue-conduction and aerial conduction respectively, and is performed by placing the tuning-fork

upon the mastoid of the side examined, observing how long it is heard, and then ascertaining whether when placed in front of the ear it is heard for a longer time or not. In the former case the test is positive, in the latter negative. In recording the results thus obtained it is usual to write a number indicating the difference in seconds between the duration of the two auditory impressions, the sign + or — being prefixed in order to show whether the determination was positive or negative. Thus the expression “Rinne + 10” means that the tuning-fork was heard ten seconds longer when placed in front of the ear than when placed upon the mastoid. A better way, however, is to make the record by a formula like the following:

“Rinne Fc₂ — A $\frac{10}{20}$ + B $\frac{15}{10}$,” which means that a low C tuning-fork which

should have been heard twenty seconds when placed in front of the ear and ten seconds when placed upon the mastoid was heard ten seconds under the former conditions and fifteen under the latter. In normal ears Rinne’s test is positive; in ears where there is considerable interference with the sound-conducting apparatus without much involvement of the sound-perceiving apparatus, it is negative; and when with involvement of the sound-conducting apparatus the sound-perceiving apparatus is also extensively impaired, it again becomes positive. This, at least, is the rule; but the rule has so great a number of exceptions that it cannot by itself serve as a means of differentiating middle-ear trouble with involvement of the labyrinth from the uncomplicated cases of otitis media. The test, however, is valuable as presumptive evidence; and when it turns out positive and at the same time the tissue-conduction generally is greatly impaired, we have fair warrant for inferring the existence of disease in the inner ear.

The second class of physical signs are those furnished by *inspection* of the drum-membrane. Although, as we have seen, the condition of the latter by no means affords a certain indication of the state of the tympanic cavity, nevertheless, as it is the only part accessible to direct observation, we must be prepared to draw from it whatever inferences we can. Hence the changes in its lustre, curvature, consistency, and tension become the objects of our closest scrutiny.

The lustre and color of the drum-membrane may be very nearly normal, and that not merely in the earlier stages of catarrhal inflammation, but also, as has been before stated, in the presence of a sclerotic process which is already far advanced. In the latter case, in fact, the membrane may so far retain its translucency as to allow us to perceive through it the reddish color of the congested mucous membrane of the promontory, and this reflex has been regarded by Schwartze as a valuable diagnostic sign of sclerotic otitis. In other cases the evidences of involvement of the drum-membrane are more marked. There may be patches of opacity, or the whole membrane may have lost its translucency, the surface at the same time becoming dull and lustreless. The normal pearly hue of the drum-head is converted into a dull, muddy or hazy gray. Sometimes the surface

has a greasy or moist look, sometimes it appears dry like paper. The cone of light becomes shortened, broadened, and irregular, sometimes splitting into two or three separate maculæ; at the same time it grows duller and finally disappears altogether. These changes in translucency, color, and the character of the cone of light are due partly to thickening of the membrane, partly to roughening and irregularity of the surface, causing decrease of its reflecting power, and partly to retraction. The surface-irregularities not only produce distortion of the normal reflex, but sometimes cause new light-reflexes to appear in other parts of the membrane. Thus, when the membrane is very much retracted it is quite common to see a spot of light upon the projecting short process of the malleus over which the drum membrane is tightly stretched. Conversely, deep hollows formed by circumscribed retractions of the drum-head appear darker than the rest of the surface. When, however, as happens very frequently indeed, the thickening of the tissues has reached a great degree, all these distinctions of surface are obliterated, and we have before us simply a porcelain-white sheet upon which no landmarks are any longer recognizable. And, on the other hand, if the case goes into the atrophic stage, the membrane may again become lustrous and may be actually more translucent than normal, so that the long process of the incus and other details of the tympanum are visible through it. When, as is frequently the case, the atrophic process is localized, inspection is often able to demonstrate the presence of circumscribed areas within which the tissues appear thinned and abnormally translucent. Thick and thin spots, or those which are translucent and opaque, may coexist in the same membrane.

The *membrana tympani* may also be slightly reddened from congestion. The congestion is usually limited to the plexus of vessels along the handle of the malleus, so that the latter stands out like a reddened bar upon the pale drum-membrane. This manubrial congestion is particularly pronounced in the cases of initial sclerosis in which the rest of the membrane shows little alteration.

Besides the diffused or localized changes in the color of the drum-membrane due to thickening and surface-irregularities, sharply-circumscribed opacities may also occur caused by degenerative processes. Thus, clear-cut, chalky-white opacities are not infrequently found as the result of the deposition of calcareous matter. These calcareous deposits are usually crescentic in shape, and are most common in the posterior segment of the membrane.

Changes in the curvature of the membrane are almost always present. The latter is generally retracted, so that its normal concavity is greatly increased. The effect of this is to produce a perspective foreshortening of the two characteristic markings upon the exterior surface of the drum-membrane which start from the umbo,—the handle of the malleus and the cone of light. The former is apparently elevated and shortened, so as to be more horizontal than normal. The latter is shortened and broadened; frequently also distorted and dulled. The evidences, however, afforded by

the cone of light are of less significance than those afforded by the malleus, since, as before noted, they may be due to thickening and roughening of the drum-membrane as well as to its retraction. The drawing in of the membrane not only foreshortens the handle of the malleus, but also renders the short process more prominent, so that it often stands out as a knuckle-shaped projection beneath the tightly-drawn drum-head. Other evidences of changes in curvature, obvious to the practised eye, are more or less pronounced alterations of shading indicative of prominences or hollows in the surface of the membrane.

The changes in curvature, like the opacities and thickenings of the membrane, may be quite circumscribed. Particularly deep localized depressions are found at the spots where adhesions exist between the membrana tympani and the inner wall of the drum-cavity.

Changes in the consistence and tension of the membrane, which are exceedingly common, are not always recognizable by inspection alone. Thus, while we can in general safely say that a very white and opaque drum-head is thickened and rigid and that an abnormally translucent one is atrophic, there are many cases in which the external appearances afford no criterion of the amount of structural change that has taken place in the membrane. Marked opacity of the drum-head, for example, may be due more to surface-irregularity than to absolute thickening; and a membrane which from its great retraction appears to be extremely tense may turn out to be unusually flabby and resilient. Hence, in order to get the best judgment in regard to the degree of structural alteration, we combine our inspection with the pneumatic tests (Politzerization), in order to determine the mobility of the membrane and thus get some idea of its consistence, tension, and fixity.

It must not be forgotten, in inspecting the membrane, that the appearances presented may be much modified by intercurrent attacks of inflammation, either catarrhal or suppurative. Such an attack may cause temporary congestion and swelling of sufficient magnitude to mask the ordinary signs of catarrh, and it may leave behind it permanent perforations or cicatrices. These latter appearances, however, may be produced, without the intervention of any suppurative inflammation, by a simple process of atrophy.

The third means of diagnosing the condition of the tympanum in catarrhal otitis is by the *pneumatic tests*,—i.e., by the artificial alteration of the intra-tympanic pressure. This is effected by rarefying or condensing the air either in the tympanic cavity or in the external auditory canal. We can condense the air in the tympanum itself by forcing in an additional charge through the Eustachian tube; this being accomplished either by the Valsalvan method, by Politzerization, or by the catheter. The Valsalvan method is not to be employed, habitually at least, as it tends to cause congestion of the head and hence of the tympanum. Politzerization is not open to this objection, and, being usually efficient, is the method oftenest employed. Catheterization, which is generally quite disagreeable to the patient, is reserved

for those cases in which Politzerization is not successful in forcing air up the Eustachian tube.¹ Whichever method we adopt, we must supplement it by inspection of the membrane to see if the latter moves during the entrance of air into the middle ear, or by auscultation with the diagnostic tube, to ascertain whether the air really enters the tympanum. In this way we are able to determine whether the Eustachian tube is pervious or not, and if pervious whether it is normally or abnormally patulous. Again, by testing the hearing before and after Politzerization, we can ascertain how far the deafness is due to Eustachian occlusion and how far to other less remediable causes. And in the third place, by watching through the speculum the behavior of the drum-membrane under inflation, we can make out whether the membrane is rigidly fixed, normally mobile, or abnormally flaccid. These changes in mobility recognizable by inspection during the act of inflation may be general and distributed over the entire drum-head or may be localized,—a circumscribed opacity or adhesion rendering the parts unduly rigid and a circumscribed atrophy rendering them unusually flaccid at some spot. In very many cases the abnormal mobility of the membrane may be recognized without any artificial alteration of the intra-tympanic pressure. This is the case with the so-called manometric cicatrices of the drum-head, in which defects of the latter have been closed in simply by the dermic layer. The latter being distensible, such cicatrices show movements coincident with even slight variations of tympanic pressure, such as those caused by the movements of respiration, deglutition, gaping, etc. The cicatrices appear usually to be due to suppurative inflammation, but, as before remarked, similar flaccid spots may be due to the simple atrophic processes of catarrh.

It remains for us to determine what conclusions can be safely made with the aid of these methods; in other words, how far we can be advanced by them in our diagnosis of a case of catarrhal otitis media. In answering this question we must have a clear understanding of what we wish to ascertain by means of them. If all that we desired to know was whether we were dealing with a case of aural catarrh or not, there would be no difficulty in the diagnosis. Most cases of this disease, in fact, can be diagnosticated from the subjective symptoms alone. Given a patient with a history of long-existing deafness and tinnitus unaccompanied by discharge or acute symptoms, and without looking at the ear we can say that the case is one of catarrhal otitis or of cerumen. In ninety cases out of a hundred it will be the former, and of the remaining ten fully five, although suffering from cerumen, will owe their deafness to catarrhal otitis. Moreover, if there is any doubt, a glance through the speculum will generally dispel it. The prominent short process, the foreshortened handle of the malleus, the distorted cone of light, and the more or less hazy and opaque-looking mem-

¹ Siegle's otoscope, by which the drum-head is sucked out or driven in by rarefaction or condensation of air in the external auditory meatus, is also sometimes employed for this purpose.

brane produce a very characteristic appearance. Even in those cases in which the translucency and lustre of the drum-head have suffered little impairment, or are actually greater than normal, the signs of retraction are almost invariably present. Hence the diagnosis of the mere existence of aural catarrh is a very easy matter. But for purposes of prognosis and treatment we require to know much more than this. We wish, in fact, to learn the nature, stage, and extent of the morbid process; and more particularly we wish to learn whether the inflammation has assumed the hypertrophic or the sclerotic form, and whether the inner ear is at all extensively involved. The determination of these points is by no means easy; often, indeed, it is impossible. The points sketched in the following outline may conduce to the correct diagnosis in well-marked cases.

HYPERTROPHIC AND HYPERÆMIC FORM OF CATARRHAL OTITIS MEDIA.

Often shows marked exacerbations and remission of symptoms (especially of tinnitus and vertigo), either as the result of natural causes or of appropriate causal and constitutional treatment.

Paracusis Willisii less apt to occur.

Hearing-distance for voice, watch, and acoumeter proportionally reduced.

Politzerization and catheterization often give evidence of obstruction of Eustachian tube, and by temporarily removing this obstruction these measures often cause marked (temporary) relief of the deafness and tinnitus.

Drum-head usually shows considerable thickening and opacity, as well as retraction, but is frequently quite mobile under Politzerization.

OTITIS MEDIA CATARRHALIS CHRONICA WITHOUT INVOLVEMENT OF INTERNAL EAR.

Catarrh is usually of the hypertrophic variety (see preceding scheme).

Tinnitus liable to various changes, but usually increasing in severity and frequency as the disease goes on.

ATROPHIC AND SCLEROTIC FORM OF CA- TARRHAL OTITIS MEDIA.

Symptoms show little remission; any marked exacerbation that occurs is usually permanent and due to involvement of internal ear.

Paracusis Willisii frequent.

Hearing-distance for voice often shows a greater relative reduction than does that for the watch and acoumeter.

Eustachian tube often unduly patulous. Politzerization and catheterization produce little or no relief.

Drum-head often but little changed in external appearance and translucency, although usually retracted and remaining rigid under Politzerization. In advanced cases evidently thinned, abnormally translucent, and flaccid. In cases of initial sclerosis, there is often permanent congestion of the manubrial plexus and a congestion of the inner tympanic wall, visible through the posterior half of the membrane as a reddish reflection.

OTITIS MEDIA CATARRHALIS CHRONICA WITH INVOLVEMENT OF INTERNAL EAR.

Symptoms of sclerosis usually marked. Deafness very little improved by treatment and liable to sudden permanent exacerbations.

Tinnitus at first may be severe and constant; afterwards may decrease and even disappear altogether.

OTITIS MEDIA CATARRHALIS CHRONICA
WITHOUT INVOLVEMENT OF INTERNAL
EAR. —*Continued.*

The tissue-conduction (as measured by the tuning-fork placed on the vertex) of sound usually greater than normal on the affected side.

Rinne's test often negative.

Hearing may be the same for all notes of the scale.

OTITIS MEDIA CATARRHALIS CHRONICA
WITH INVOLVEMENT OF INTERNAL EAR.
—*Continued.*

Tissue-conduction diminished or even abrogated on the affected side.

Rinne's test positive.

Hearing frequently diminished for the highest notes (test with König's rods).

The differential signs above given are far from being of absolute value. The limitations to their applicability have already been indicated. Nevertheless, they are useful as presumptive evidence; and when all the signs point in one direction, we can fairly assume that the indications which they afford are correct. We are, for example, justified in inferring the existence of sclerosis when, in a case of marked deafness, we find the Eustachian tube freely pervious and the drum-head nearly normal in outward appearance, but considerably retracted and not very mobile under the influence of Politzerization. In such a case we should also expect to meet with involvement of the internal ear, and our suspicions in this direction would be confirmed if we find that the tuning-fork is inaudible in the affected ear when placed either upon the vertex or the mastoid.

PROGNOSIS.

The prognosis of chronic catarrhal otitis depends upon the age of the patient, the state of his general health and the conditions which influence it, and the amount of damage which the ear has already suffered from.

Age is of importance in determining the prognosis, for two reasons. In the first place, an old man is likely to have had the disease a long time, so that with him there is more chance of the existence of irreparable changes in the organ of hearing and particularly in the internal ear. Every case of advanced catarrhal otitis, in fact, is probably complicated to a greater or less extent with lesions of the labyrinth due either to the direct transmission of inflammation from the tympanum or to the effect of long-continued disturbances of pressure. In the second place, catarrhal otitis occurring in old age is aggravated by the natural degeneration of the tissues incident to advancing years, which, on the one hand, adds to the existing functional disturbance, and, on the other, lessens the resisting power and interferes with the processes of tissue-repair and so prevents a recovery. That is, an old man who hears imperfectly in any case will have this deafness of senility superadded to the deafness due to his catarrh, and, owing to the sluggishness of his circulation and tissue-metamorphosis, will show much less disposition than a younger person to throw off the morbid condition and initiate the processes of repair. This tendency to diminished resistance increases with advancing years, and hence we can in general say that the prognosis of catarrhal otitis media becomes worse with age.

The *state of the health* also exerts an important influence in determining the prognosis. As has been seen, catarrhal otitis is induced and kept up by various causes which depress the general system. As long as this depression continues, the cause of the otitis is still present, and hence the latter itself cannot be adequately remedied. Aural catarrh, indeed, being mainly an expression of systemic depreciation, is aggravated by all causes which still further depress the system. Hence ill health from whatever cause tends to make the trouble worse, or at least to interfere with recovery. This is particularly the case when the ill health is due to a continuance of the causes the constant repetition of which had originally given rise to the catarrh. The prognosis, accordingly, is rendered worse when circumstances force the patient to be constantly exposed to the same depressing, unhygienic agencies that have been pointed out as efficient in the production of the otitis. Unfortunately, this is the case with the great majority of patients. But few can so alter their ways or place of living as to insure themselves immunity from the numerous causes that are provocative of catarrh. In those who can do so the prognosis is of course much more favorable, other things being equal, than in their less fortunate companions who are obliged to remain subjected to deleterious influences. We may go a step further, and say that, with the exception of the comparatively rare instances in which an initial sclerotic process exists, all cases of catarrhal otitis would obtain a good prognosis if the conditions under which the patients live could be suitably altered and if the cases could be taken in hand early in life,—*i.e.*, before irreparable changes had taken place in the middle and internal ear. Unfortunately, the reverse of both of these conditions usually prevails, so that we are obliged to characterize the prognosis of chronic catarrhal otitis as in general unfavorable. That is, a case of aural catarrh will usually tend to get worse in spite of all ordinary therapeutic measures that can be brought to bear upon it. We say ordinary therapeutic measures, for the radical treatment by operation, described later on, does effect a permanent cure. It does so, however, simply by removing the parts that are hopelessly diseased, and not by counteracting the disease itself; and hence it really forms no exception to the rule that all means aiming to arrest the progress of catarrh of the middle ear directly are in the end unavailing.

The third important element in determining the prognosis is the *extent of damage* which the disease has already inflicted upon the auditory apparatus by the time that the case comes under observation. A review of the pathological conditions met with in aural catarrh will show us that some of the lesions that the latter induces are susceptible of retrogression, while others are not. Hyperæmia readily disappears when its cause is removed, and an exudation, if it is not already organized, can be absorbed. But connective tissue, when once developed, remains; and parts that have once been atrophied by sclerosis cannot be regenerated. Hence catarrh in the hypertrophic and hyperæmic stage affords a much better prognosis than

catarrh which has already assumed the sclerotic form. Of particularly evil import are those cases in which there appears to be no hypertrophic stage at all, the pathological process being a sclerotic one from the outset. In such cases there is a steady diminution of hearing, and the symptoms are not relieved even temporarily by Politzerization, catheterization, or constitutional treatment. Moreover, labyrinthine complications are apt to set in early and make the prognosis materially worse. This involvement of the internal ear constitutes the worst complication of aural catarrh in whatever stage it may be, since the lesions which it produces are, except in the rarest cases, irreparable. Hence we may say that the prognosis of catarrhal otitis media is worse in proportion as the disease tends to assume the sclerotic form and in proportion as the involvement of the internal ear becomes more pronounced. Accordingly, those cases are to be regarded as most hopeless in which there is extreme deafness, showing but little spontaneous variation from day to day and practically no variation as the result of treatment, and in which an enfeebled or absent tissue-conduction of sound points to a marked affection of the labyrinth. If these signs coexist with a nearly normal, quite translucent drum-head, the presumption in favor of a bad prognosis is still further heightened, inasmuch as this appearance would lead us to regard the trouble as mainly due to sclerosis of the inner wall of the tympanum and involvement of the labyrinth. The presence of paracusis Willisii, as probably implying a condition of sclerosis, has also been regarded as of unfavorable prognostic significance; but this, as before remarked, must be accepted with considerable reserve.

The conditions stated above as determining the prognosis apply to the course of the disease itself and to its main symptom, deafness. The prognosis with respect to the two other chief symptoms—namely, tinnitus and vertigo—is more uncertain. These effects of catarrh are much more inconstant in their development than is deafness, and are also more subject to spontaneous variations even in the later stages of the disease; hence we cannot say of them, as we can of deafness, that they will necessarily increase in severity as the trouble advances. In fact, when the affection of the labyrinth gets to be very pronounced, the tinnitus, so far from increasing, may disappear altogether. Nevertheless, although subject to great variations, both tinnitus and vertigo in general tend to grow worse with the progress of the catarrh, and are not much more affected by treatment than deafness is; hence in respect to them also the prognosis, although not absolutely bad, is unfavorable in most of the cases that we meet with in practice.

TREATMENT.

The treatment of chronic catarrhal otitis is either causal or symptomatic. In other words, it may aim to do away with the agencies that induce the pathological condition, or it may seek to remove the effects to which the latter has given rise.

In view of the pathogenesis of catarrh, the *causal* treatment would seem the most rational procedure; and, indeed, as before stated, if it could be carried out efficiently and early, it would in most cases accomplish a cure. Unfortunately, nearly all the cases come to us after the disease has already lasted for years and has inflicted more or less irreparable damage, and, furthermore, it is impossible for most of the patients to carry out a causal treatment in any adequate way. Those, for example, who suffer from catarrhal otitis as a consequence of the unhygienic influences of city life, are scarcely ever able to change their residence and place themselves in healthier surroundings, and the few that are able to do so are usually those well on in years, in whom a vitiated system due to their previous mode of life and advancing age do not allow them to throw off the morbid condition, and in whom the ear is already, to a great extent, rendered incapable of repair by long-continued inflammation and its consequences. In another set of cases, in which the catarrhal condition is due to bad diet, bad air, lack of exercise, overwork, and excitement, the application of a causal treatment is frustrated by the inability of the patient from economic reasons to alter any of the injurious conditions under which he lives. Nevertheless, although our efforts in this direction must be largely futile, we must always endeavor to apply the causal treatment; and in certain cases, particularly in the young, who have great reparative power and in whom the disease has not usually advanced very far, we may succeed in effecting a great deal of improvement by its aid. Whether an actual cure is ever effected by this means, in the sense of restoring the ear to its normal state, must be doubted; and, as an ear which has once been the subject of aural catarrh is extremely likely to suffer from a recurrence of the disease upon a renewal of the exciting cause, we must always warn our patients that the relief is only a provisional one, and that its continuance is dependent upon their taking proper care of themselves. By a statement of this sort much disappointment may sometimes be avoided.

The chief agencies provocative of catarrh, for the cure of which a properly-directed causal treatment can be instituted, are unfavorable climatic conditions, unhygienic conditions of life, disease producing debility, and the reflex and exciting causes proceeding from other organs.

The unfavorable *climatic conditions* which can be most effectually remedied by treatment are mainly those varieties of artificial climate which have already been pointed out as conducing to the development of catarrh. Much may be done in the way of insuring proper ventilation and moisture so as to prevent overheating and undue dryness of the air of apartments and at the same time avoid draughts. This is not a very easy matter in furnace-heated and, more particularly, in steam-heated houses. Here the usual error is in overheating and desiccating the air of the rooms. Then, when the dryness and heat become unbearable, the windows are opened and a supply of cold moist air is admitted, to the detriment of those exposed to it, whose superheated bodies are specially apt to react unfavorably to this sudden

change. Both of these extremes should be avoided. Again, proper provision can be made in the matter of clothing for those who are exposed to frequent sudden alternations of temperature in cars and steamboats, in churches, schools, theatres, and other public buildings, and at balls or similar entertainments. Particularly should such alternations of heat and cold be provided against for those who, from any cause, are run down or naturally feeble, as persons of deficient stamina are specially liable to suffer from the effects of changes of temperature.

Unhygienic surroundings and ways of living, which produce catarrh, may often be remedied. Thus, the liability to catarrh may possibly be lessened by attention to the air-supply, drainage, and other factors of environment. But much more can be accomplished both in the way of prophylaxis and treatment by care in respect to the regulation of the diet and habits of the patient. The evil effects of excessive and injudicious feeding, especially in children, have already been enlarged upon, and it remains only to add that the best results accrue from the correction of this error. The diet, therefore, in every instance should be the object of careful attention, and when, as is usually the case, it is excessive in quantity or overstimulating in quality, it should be cut down and made plainer and simpler. This rule is particularly to be observed with children, who are apt to suffer the most from errors of this sort, but it should by no means be left out of sight in dealing with adults. With the latter, also, the question of alcoholic beverages and of tobacco as determining agents in the causation of catarrh should be taken into account, and, if necessary, a proper restriction or even absolute interdiction be placed upon the use of these stimulants. In both children and adults a suitable amount of physical exercise in the open air should be insisted upon; and in both the exhausting effects of over-work, over-excitement, and worry should, as far as possible, be diminished by such restrictions as it may be possible to enforce.

Constitutional disease existing in a catarrhal subject should receive the appropriate treatment. For, whether directly responsible for the catarrhal state or not, it undoubtedly fosters the perpetuation of the latter by maintaining a condition of systemic depreciation. Hence the cause of any existing ill health must be inquired into and combated by tonics or other suitable means. When this is done and the general condition thereby improved, the catarrh which before had obstinately persisted may for the first time display a tendency to recovery. Moreover, such general treatment is not only useful in accelerating the processes of absorption and repair and so facilitating the cure of the catarrhal condition, but it also acts prophylactically by putting the patient in better condition to withstand future attacks.

A similar line of reasoning applies to treatment directed towards the *reflex and other exciting causes* of catarrh. That is, the relief of a morbid state which by reflex irritation may set up a catarrhal trouble or aggravate one that already exists, is called for not only as a means of hastening the

cure of such a trouble when present, but also as a means of preventing future attacks. The morbid states which may act in this way as pathogenic agents have already been touched upon. It is sufficient to say that in a case of catarrhal otitis it is well to inquire into and to correct any disturbance of the stomach, the genito-urinary tract, and particularly of the buccal and pharyngeal cavities. The influence of bad teeth in affecting the ears by reflex action has been already spoken of, and the author has a number of times had occasion to observe the happy results following the correction of defects of this nature. Indeed, it is his practice to examine the teeth in cases of middle-ear trouble, and where any cause of oral irritation is present to advise its removal. He is particularly impressed with the importance of removing dead teeth, the slow and unnoticed decay of which causes constant irritation. Such teeth, by an erroneous conservatism, are often permitted to remain, without regard to the remote deleterious consequences which they may engender.

Among the causes of catarrh, that which has hitherto excited the most attention, both on account of its apparent directness of connection with the latter and also on account of its apparent frequency, is inflammation of the naso-pharynx. It has been supposed that aural catarrh is in most cases not simply the concomitant but, in fact, the direct result of a naso-pharyngeal lesion which has been propagated by direct continuity along the Eustachian tube. According to this view, the chief treatment for catarrhal otitis would consist in attempts at relieving the causal condition existing in the throat and nose; and as a matter of fact this notion has been and still is maintained as the exclusively true one. This idea has been already considered in the section upon etiology, where the conclusion is reached that catarrh of the middle ear and catarrh of the naso-pharynx are much oftener associated conditions due to a common cause than interdependent states one of which succeeds the other. This view of the case seems to be confirmed not only by theoretical considerations but also by the practical fact that in the great mass of cases treatment directed to the throat and nose does not cure catarrhal otitis. Of course there are exceptional instances in which it does do so, and the author does not intend to deny the value of appropriate treatment to the naso-pharynx in such cases. Those, however, who employ it as a routine measure and persist in its employment will undoubtedly in most cases meet with disappointment, and in not a few instances will actually inflict harm by setting up an acute ear-trouble as the result of their interference with the pharyngeal structures.

The *symptomatic treatment* of catarrhal otitis, which aims at relieving or removing the consequences due to the pathological changes, has hitherto been mainly confined to attempts at restoring the normal tension of the drum-head through renewal of the intra-tympanic air. This is effected by the use of the *Politzer bag* and of the *Eustachian catheter*, instruments which, by forcing air into the tympanic cavity, increase the pressure there and force the retracted membrane outward. In cases where there is tem-

porary occlusion of the Eustachian tube and where the retraction of the drum-head and the pushing in of the chain of ossicles are mere functional changes due to diminished aerial pressure in the middle ear, these procedures undoubtedly effect their object, and may be followed by marked increase in the hearing. But where there is actual fixation of the ossicles and where the drum-membrane is rigid from structural changes, propulsion of air through the Eustachian tube can at most only overcome occlusion of the latter, and, as this occlusion is not the cause of the deafness, Politzerization can be of no service in remedying the functional defect. Hence the routine employment of this procedure, such as is so often practised, cannot accomplish good, and in some instances it may even do harm by straining and rendering still more flaccid an already atrophic and degenerated drum-head. These remarks apply with special force to cases in which the Eustachian tube is unduly patulous. This condition is quite common in the sclerotic stage of catarrh, in which, therefore, Politzerization should be used with great caution or preferably not at all.

The *injection of vapors or liquids into the tympanum* through the Eustachian tube has been advocated as a means of directly medicating the mucous membrane. Iodine, chloroform diluted with alcohol, and similar agents have been thus employed. The results of this treatment have not been satisfactory. The catarrhal condition in most cases is not at all affected by the injections, and in a certain proportion of cases the disease is aggravated by them. If used at all, such injections would seem to find their appropriate employment in the earliest stages of catarrh, when great swelling of the mucous membrane with consequent occlusion of the Eustachian tube exists. In such cases, air charged with volatile vapor may overcome the occlusion when the injection of ordinary air is unable to do so.

The author mentions the employment of *electricity* only to condemn it. He has never seen the slightest benefit accrue from its use.

The other varieties of symptomatic treatment in vogue are the different operative measures upon the tympanum and its contents, including paracentesis of the drum-head, tenotomy of the tensor tympani and of the stapedius, and the radical operation for the removal of the drum-head and ossicles.

Paracentesis or *excision* of a portion of the drum-membrane is one of the oldest operations upon the ear, having been done repeatedly ever since otology began to be a science. The utility of making and maintaining an opening in the drum-head in cases of aural catarrh was demonstrated by Sir Astley Cooper in England, and by Himly in Germany; but both of these surgeons found that the good results were nullified by subsequent closure of the orifice. This tendency of an artificial opening to close up again has been encountered by all subsequent observers. Some have endeavored to counteract it by the use of the cautery or by inserting eyelets in the perforation. These procedures, however, have been entirely unsuccessful in accomplishing their object. Others have advocated multiple repeated punctures of the membrana tympani. It is stated that fifty or more

such punctures may be performed without injury and even with manifest advantage. The results of this procedure, however, have not commended themselves to most aural surgeons.¹

One serious objection to either of the above forms of operative treatment is that they do not remedy one of the most important elements in the production of functional disturbance,—namely, the rigidity of the chain of ossicles. Ankylosis and immobility of the latter are obviously not affected by mere removal of a portion of the drum-head, any more than they are by the propulsion of air through the Eustachian tube. In either case, whatever may be the effect upon the drum-membrane, the bones, being rigidly fixed, are not altered in their relations to one another and to the fenestra ovalis. Hence other means have been devised looking towards a restoration of the natural mobility of the ossicular chain. Among these are *tenotomy of the tensor tympani* and of the *stapedius*. These operations are based upon the assumption that the rigidity of the ossicles is due to contraction of these muscles. This contraction, however, although doubtless existing in many cases, is only one of the many conditions of sclerosis found in the tympanic cavity, and, consequently, to remedy it is to do away with but one (and in most cases the least important one) of the pathological factors producing functional disturbance. Hence these operations have a very limited range of application; and as what they effect is accomplished much more thoroughly by the more radical operation to be presently described, it seems hard to see why the latter should not in all cases be given the preference. This is particularly the case with regard to all operations for dividing the stapedius or for “mobilizing” the stapes. From a pretty extensive experience with aural operations the author can assert that it is rarely possible to bring the stapes into view in such a way as to operate upon it or the muscular structures attached to it in a satisfactory manner; nor, as far as he has seen, is there any occasion for rendering this end of the ossicular chain mobile, provided the two larger ossicles, which constitute the main element of resistance to sound-conduction, are removed.

The radical operation above referred to constitutes, according to our experience, by far the most efficient of all the varieties of symptomatic treatment. It is really curative in the sense that it not only arrests the further progress of the disease and conserves whatever degree of functional capacity is left, but also in most cases causes marked improvement in the hearing and a permanent abolition of the tinnitus. It does this by removing the parts which, being no longer serviceable for the transmission of sonorous vibrations, are actually an impediment to the latter. It consists, that is, in the *excision of the drum-head and the two larger ossicles*, which have

¹ It must not be inferred from this statement that paracentesis is never to be performed in chronic catarrh. When done for the removal of liquid exudates from the drum-cavity in cases where the latter is over-distended and the membrane bulging, it is a perfectly legitimate and often beneficial procedure. The statement made in the text applies to paracentesis performed with the sole object of restoring the normal intra-tympanic pressure.

become unserviceable through rigidity or, in some cases, through undue

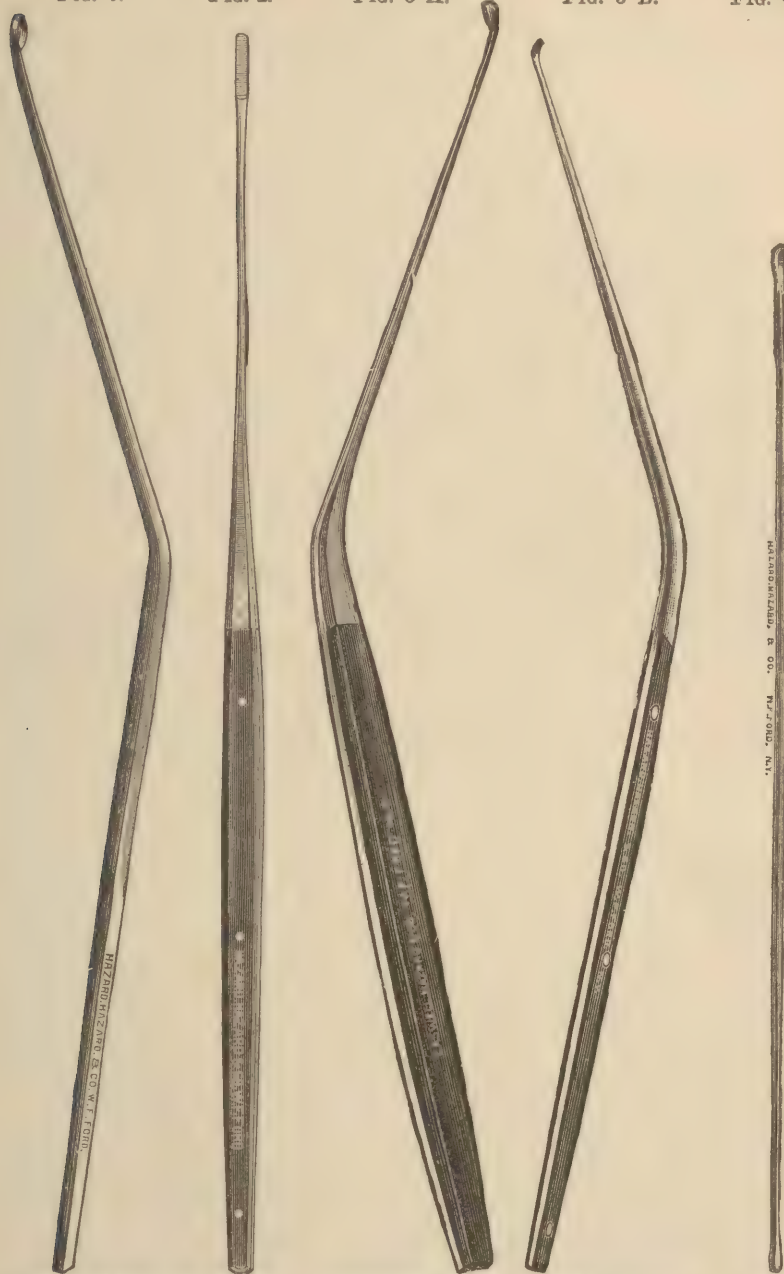
FIG. 1.

FIG. 2.

FIG. 3 A.

FIG. 3 B.

FIG. 4.

Transfixion knife.
(Natural size.)Blunt-pointed
knife.
(Natural size.)Incus knife (right).
(Natural size.)Incus knife (left).
(Natural size.)Probe.
(Natural size.)

relaxation. The result is that the sound-waves arrive directly at the inner wall of the tympanum and there impinge upon the fenestræ connecting the

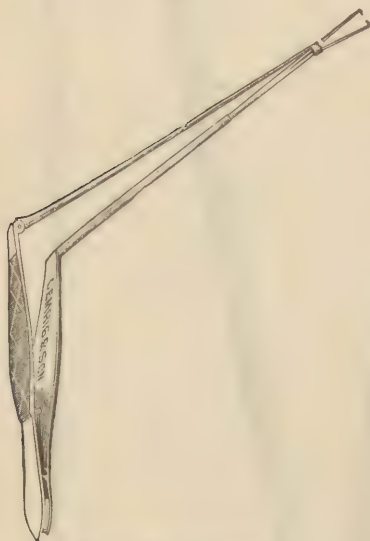
latter with the labyrinth, so that they are transmitted to the latter without the intervention of a clogged and rigid conducting mechanism, and are appreciated much more distinctly than when this mechanism was present. Moreover, the disturbances of labyrinthine pressure due to the altered tension of this same conducting mechanism are removed with the removal of the latter.

The operation requires for its proper performance perfect control of the patient, secured by the administration of a general anæsthetic to the surgical degree, and brilliant illumination of the field of operation, secured by the use of the electric head-light. The patient is placed upon a table with his head slightly elevated, and the room is darkened. The instruments required for the operation are an angular knife for transfixing the membrane (Fig. 1), a blunt-pointed knife¹ (Fig. 2) for cutting the latter away, an angular knife (one for the left and one for the right side) for disarticulating the incus (Figs. 3 A and 3 B) from the stapes, a bent probe to pull down the bones into view when necessary (Fig. 4), a foreign-body forceps (Fig. 5) for removing the ossicles, and a dozen or more cotton-holders, all armed with cotton before the operation, together with a syringe and hot water to check any bleeding.

The steps of the operation are as follows. The membrane is first transfixed behind the short process of the malleus with the angular knife (Fig. 1); then the membrane is divided all round the periphery posteriorly by the blunt-pointed flat or curved knife (Fig. 2); then the same operation is repeated anteriorly. The membrane being thus detached, the articulation between the stapes and incus is divided by the specially devised knife (Fig. 3 A or 3 B); the incus is brought down and removed; and then, the attachments of the malleus having been cut all round with the trowel-shaped knife, the malleus is removed with the forceps (Fig. 5). The wound is then dressed with a little iodoform powder and a plug of cotton.

The performance of the operation in expert hands takes from five to fifteen minutes, depending upon the amount of bleeding, the presence of adhesions, and other sources of embarrassment to the operator. In doing it, it is essential to keep the field of view clear from

FIG. 5.



Foreign-body forceps.

¹ The usual form of this has a flat blade, but recently the author has devised one with a curved blade, adapted for those cases in which a sharp bend at the bottom of the auditory canal prevents the flat knife from reaching the periphery of the membrane.

blood by rapid repeated application of the cotton-holders, and to have it perfectly illuminated with the electric light. The use of a magnifying-glass every now and then is an important aid to some eyes in examining the parts. It is important not to wound parts other than those removed. It is not, however, always possible to prevent injury to the chorda tympani nerve,—an injury, nevertheless, which is of little practical moment, as the disturbance of taste to which it gives rise is always transitory.

The operation is followed by but little inflammatory reaction and usually no pain. The patient is kept quiet till the following day, and for one or two days after the operation. It is well to caution him not to make sudden movements of the head, as these are apt to cause temporary vertigo. It is the author's practice to restrict the patient's diet both before the operation and after it during the time of healing, as he is persuaded that regeneration of the excised drum-head is thereby hindered.

The results of the operation¹ have, in the author's experience, been most gratifying. Not only is a stop put to the progress of the disease, but the hearing-power usually shows an increase, which in some instances is very marked indeed. For example, in one of the author's cases, before the operation ordinary voice was heard at six inches, after the operation at twenty feet. While, of course, such a change as this is not often met with, yet in nearly all the author's cases there was more or less improvement in hearing, and in most of them such as was very distinctly appreciable by the patient and such as largely increased his capacity for the enjoyment of conversation, music, and public speaking. The improvement in function is usually immediate; indeed, it is sometimes so great that, as the patient is emerging from the effect of the anæsthetic, ordinary sounds appear to him to be of painful intensity. The tinnitus, too, usually disappears altogether. This improvement in the condition is, as a rule, permanent, unless there is regeneration of the drum-head; in this case the deafness returns, although the tinnitus does not. Regeneration of the drum-head can be prevented in most cases by care in the operation and by abstention from meddling interference in the after-treatment. The after-treatment, indeed, is extremely simple, and consists mainly in the use of cotton plugs, changed as often as cleanliness requires. All probing, syringing, and rough handling should be avoided, and whatever cleansing is done should be performed in the most careful possible way. If, nevertheless, regeneration should occur, it is better not to attempt to arrest it. Later on, when the perforation has completely healed over, the new-formed drum-head can be excised without trouble. This may have to be done more than once, but such is not the rule.

The operation is indicated wherever the constitutional and causal treatment seems likely to be of no avail,—*i.e.*, in cases which are already pretty

¹ See Sexton, "The Ear and its Diseases;" Sexton, Archives of Otolaryngology, April, 1891; Sexton and Duane, "The Rational Cure of Deafness, etc.," J. H. Vail & Co., New York, 1892.

well advanced, and especially those in which there is evidently rigidity of the ossicles and the formation of new connective tissue in the tympanum. But even in cases to which general treatment seems applicable—namely, in young subjects and those with hypertrophic catarrh—the operation should not be deferred if it is evident that the disease is progressing and that general treatment is proving inefficient. For, if such cases are allowed to run on, the result, when the operation is at length performed, will be much less satisfactory than if the latter had been done early. The operation cannot, of course, remedy structural changes that have occurred in the internal ear, and the liability for the development of these increases with the duration of the middle-ear disease. Hence, if the latter is allowed to continue too long, the operation, although relieving the symptoms that are due to the catarrhal otitis media, may not effect much change in the condition, simply because the internal ear has become so greatly affected. Nevertheless, the operation may be done even in the extreme cases of sclerotic otitis in which the labyrinth is almost certainly involved, as it will at least maintain the *status quo*, and, even if it does not increase the hearing-power, will still probably do away with the tinnitus.

The author would, therefore, *sum up* the rules for the treatment of aural catarrh in the following statement. Place the patient in any case in the best condition possible by guarding him from changes of temperature and moisture, by improving his hygienic surroundings, carefully attending to his diet, removing all causes of reflex irritation, and in all ways striving to improve the general health and tone of the system. In addition, if the case seems to be a recent one in which hypertrophy and hyperæmia of the mucous membrane and occlusion of the Eustachian tube play the principal part, general treatment may be supplemented by the judicious use of the Politzer bag and catheter, and in selected cases by local treatment of the naso-pharyngeal catarrh. Should both general and local measures of this sort not produce a speedy improvement, no further time must be wasted, and the radical operation must be done without delay.

THE MIDDLE EAR

IN RENAL, MALARIAL, SYPHILITIC, GOUTY, RHEUMATIC,
AND DENTAL DISEASES; WITH A CONSIDERATION
OF OBJECTIVE NOISES IN THE EAR.

BY CHRISTOPHER J. COLLES, M.D.,

Assistant Surgeon, Throat Department, Vanderbilt Clinic, College of Physicians and
Surgeons, New York; formerly Assistant Aural Surgeon, New York Eye
and Ear Infirmary, and Assistant Surgeon, Throat Department,
Demilt Dispensary, New York.

THE occurrence of catarrhal affections of the middle ear with and during the course of other diseases affecting the general system has been the object of frequent observations on the part of different writers, published cases appertaining thereto appearing from time to time. Under the influence of unfavorable conditions of the economy, such as scrofulosis, anæmia, tuberculosis, etc., catarrh of the middle ear may develop, with an initial acute stage or as an accompanying phenomenon in general diseases. This assertion is, however, denied by Kramer,¹ who insists that we can only recognize and describe inflammations of the drum-head and other affections in the external and middle ear as occurring in scrofulous, rachitic, or gouty persons, or in those subject to other dyscrasias, but that we are not warranted in speaking of a scrofulous, gouty, or rachitic disease of the ears.

There are, however, many points in respect to which middle-ear catarrh may present considerable differences when arising during the course of various constitutional diseases. It will be advisable, therefore, to consider under separate headings the different causative diseases as we find them designated in the title of this article.

RENAL DISEASES.

Although early writers on diseases of the ear have referred to the fact that loss of hearing and other aural troubles had been observed by them in the course of general diseases, such as those of the urinary organs, yet up to the time when Rau published his work on ear-diseases, in 1856, in Berlin, there had not been recorded a single reliable observation on the pathological relations between the ear and the kidneys. In the year 1868 a case of hemor-

¹ The Aural Surgery of the Present Day. London, 1863, p. 2.

rhage into the tympanum, occurring in the course of nephritis, was reported by Schwartze.¹ In the same year, also, G. M. Smith² called attention to the alteration in the hearing-power taking place sometimes during the course of Bright's disease, at the same time stating that the symptom was one not explainable by referring it to uræmia. Roosa³ mentions a case of suppurative inflammation of the middle ear in the course of Bright's disease in a patient sixty-one years of age, which gave rise to much pain and suffering, probably of a neuralgic character.

According to some authorities, notably Dieulafoy,⁴ deafness in various degrees is much more frequently met with in the course of Bright's disease than one would naturally be inclined to suppose from the small number of cases recorded. Dieulafoy, since his attention was seriously attracted to this field of observation, reported that he had found various affections of the ear, varying from total deafness to a slight loss of the hearing-power and tinnitus aurium, in fifteen out of thirty-seven cases of chronic or acute nephritis. The aural disturbances may occur at any stage of the renal disease, although generally in the more advanced period of the same,—for example, in eleven out of fifteen cases contemporary with the œdema. Dieulafoy found that these disorders of audition are generally only temporary, their duration being of a few days or weeks, when they gradually disappear, but usually only to recur at a later stage. The deafness may affect one or both ears at the same time, and in but one of his cases was the loss of hearing permanent.

The tinnitus was generally heard as a humming sound in one or both ears, being often introductory to the deafness. In one of Dieulafoy's patients, who had suffered with tinnitus for a year or so, De Lacharrière found permanent lesions in the membrana tympani,—namely, an abnormal vascularity of the malleal plexus on one side and thickening and depression of the other drum-head. It was also found that such auditory disorders were usually painless, although in other cases they were accompanied by severe pain in the face and ears. This writer was not able to decide as to whether such disorders should be assigned to the middle ear or auditory nerve, but considered their appearance to be of great assistance from a diagnostic point of view, for instance, in certain obscure forms of nephritis, which do not reveal themselves by œdema or other recognizable symptoms.

Pissot⁵ considers three forms of aural disturbance which may occur during the course of Bright's disease,—namely, tinnitus aurium, partial deafness, and total deafness. Such affections may arise, according to him, in any

¹ Archiv für Ohrenheilkunde, Bd. iv. S. 12.

² On the Etiology of Bright's Disease, with Remarks on the Prophylaxis. Transactions of the New York Academy of Medicine, vol. iii.

³ Diseases of the Ear, etc., seventh edition, New York, 1891, S. 301.

⁴ Gazette Hebdomadaire (Journal des Connaissances Médicales), Janvier 23, 1878.

⁵ Thèse pour le Doctorat en Médecine. Faculté de Médecine de Paris, Avril 4, 1878. American Journal of Otology, vol. i.

stage of the kidney-affection, and, like Dieulafoy, he states that they may be concurrent with the œdema or directly preceding it. They are characterized, furthermore, by their intermittence. Pissot inclined to an explanation of the aural phenomena based on the hypothesis advanced by Rosenstein, that an œdema occurs in the course of the auditory nerve within the cranium. Schwartze,¹ Urbantschitsch,² Von Troeltsch,³ Voss,⁴ and other writers, have made mention of the fact that a hyperæmia and serous catarrh of the tympanic cavity may arise during the course of Bright's disease and other general cachexiæ, due perhaps to vaso-motor disturbances or derangements in the circulatory system, owing to increased heart-action.

Buck⁵ states that in some rare cases a serous fluid tinged with blood will be found in the tympanic cavity with other origin than that of an inflammatory character; such are usually found in patients having a depraved state of the general nutrition, as in Bright's disease. This opinion is one shared by other writers, such as Raynaud⁶ and McBride,⁷ both of whom have published observations on the subject.

Dewèvre⁸ published in 1886 the account of a case of complete deafness of one ear and tinnitus occurring in the course of Bright's disease. The drum-membrane of this ear was very congested, with redness and œdema of the mastoid process. Eventually discharge set in, and the hearing returned in the course of two months. Downing⁹ also reported a case of deafness preceded by pains occurring first in one ear, and ten days later in the other, in a patient suffering from chronic nephritis. No lesion of the drum-head was observed, and inflation of the tympanic cavities afforded no relief. The hearing returned suddenly at the end of two weeks. Downing attributes the aural affection to some labyrinthine disturbance, such as œdema or hemorrhage.

Politzer,¹⁰ in his work on the ear, considers that the fundamental cause in cases of supposed connection between the organic renal disease and aural affections should be looked for in very apparent changes in the middle ear. Turnbull¹¹ apparently inclined to the views of Dieulafoy in respect to the assistance which may be acquired from these aural troubles from a diag-

¹ Pathologische Anatomie des Ohres.

² Lehrbuch der Ohrenheilkunde, 3te Aufl. Wien, 1890, p. 257.

³ Diseases of the Ear in Children. Translated by J. O. Green, 1882, p. 164.

⁴ Archiv für Ohrenheilkunde, Bd. xxvi. S. 233.

⁵ Diseases of the Ear. New York, 1889, p. 163.

⁶ Annales des Maladies de l'Oreille, etc., March, 1881.

⁷ Edinburgh Medical Journal, February and March, 1882.

⁸ On Uræmic Hemiplegia and Hemorrhagic Otitis in the Course of Bright's Disease. Lyon Médical, No. 40, October 3. 1886.

⁹ Deafness in the Course of Bright's Disease. Glasgow Medical Journal, 1886. Also, New York Medical Times, January, 1887.

¹⁰ Cassell's English Translation, 1883, Philadelphia.

¹¹ Tinnitus Aurium and the Deafness which accompanies Different Forms of Bright's Disease. Meeting of the American Medical Association, June 16, 1883.

nostic stand-point. He reported the histories of a number of cases coming under his observation. In all of them there appears to have been serous effusion into the drum-cavities and a congested condition of the membrana tympani. Whether or not the symptoms in these cases were pathognomonic Turnbull was unable to state. C. H. Burnett¹ published a report on this subject in 1884, giving a review of the literature and previous observations. From those of other authors and of himself, he was led to the following conclusions: first, that "evidences in favor of either frequent or well-marked aural lesion, dependent upon renal diseases, are extremely meagre;" secondly, that "those lesions in the ear which have been found in connection with Bright's disease, and which may have been dependent upon the dyscrasia induced by these renal disorders, are in the form of sero-sanguinolent and hemorrhagic effusions into the drum-cavity. But the latter must not be mistaken for the sthenic form of otitis media hæmorrhagica;" thirdly, that "from the serous nature of the membranous structures of the labyrinth, organic changes might reasonably be expected in Bright's disease, but positive proof of the occurrence of such lesions, based on ante- and post-mortem history, is wanting." The symptoms in these cases cannot be considered pathognomonic,—i.e., certainly as far as our knowledge of such extends; for there appears nothing especially different from an objective or subjective point of view to point to the existence of any special systemic disease. It is very probable, however, from the local conditions observed, that the lesions causing deterioration of the hearing-power are to be sought for in the tympanic cavity and its transmitting apparatus. Organic changes, we know, do occur in the course of renal diseases, notably in Bright's disease of the kidneys, and a tendency to inflammatory affections of the mucous membranes is also characteristic of these affections.

Treatment.—Local treatment in these cases, where the aural symptoms are marked and severe, should consist of such measures as are usually employed in like affections independent of the constitutional disease. Cleanliness in the local conditions is to be urged in all cases, and the avoidance of all irritation from the introduction of astringents, fluid or otherwise, as tending only to aggravate rather than allay the local disturbance.

MALARIAL DISEASES.

The supposed influence of a so-called malarial poison on the organ of hearing in persons suffering from the effects of such a disturbance of the general system has given rise to much speculation and excited the interest of otologists for some years past. The well-known tendency of the upper air-passages to inflammatory affections during the existence of all disturbances of the general economy, especially when associated with febrile move-

¹ The Supposed Connection between Ear-Disease and Kidney-Disease. The Polyclinic, Philadelphia, February 15, 1884.

ments, would explain the appearance of many catarrhal affections of the ear at such times. As to the existence of an especial form of ("malarial") catarrhal otitis media, it must be confessed that great differences of opinion obtain.

In 1871 an article by Weber-Liel¹ first described two forms of middle-ear disease which he considered were dependent upon a malarial poisoning. One of these forms he called an *otitis intermittens*, the other an *otalgia intermittens*, the former being of an inflammatory character, the latter of a non-inflammatory nature. This author considered both forms of ear-affection to be due to a neuralgia of the third branch of the trifacial nerve of a malarial origin; the inflammatory otitis being caused by a vaso-motor trophic neurosis originating in the malarial neuralgia referred to, whilst the otalgia was a simple malarial neuralgia. Weber-Liel² stated several years later that he had observed a great number of cases of acute aural inflammation belonging to the class of intermittent otitis, which, when treated as such with regard to their malarial origin, showed a rapid recovery. He emphasized, therefore, his belief that a great number of cases of acute otitis, especially those occurring in the spring and autumn of the year, were due to malarial influences. This same writer considers that, even after the severe pain felt in all branches of the trifacial and neighboring nerves, and due to the irritating influence of the malarial poison, has ceased, a vaso-motor neurosis, causing injection of the tympanic blood-vessels and a collection of muco-pus in the drum, will indicate the existence of the malaria for a considerable period of time. In respect to symptoms he states that a naso-pharyngeal catarrh or angina will usually precede the attack, which is followed by a chill towards nightfall, a feeling of fulness and roaring in the ears, and occasionally accompanied by vertigo and sense of pressure in the head. The following day the patient will be perfectly well, with no signs of aural disturbance whatever. Forty-eight hours afterwards the same symptoms take place, the aural phenomena being perhaps more intense, and deafness and pains in the ears being usually present. The exudation into the tympanum often taking place at this stage results sometimes in perforation, giving great relief. In this manner the attacks will continue after the tertian or quotidian type, the intervals affording perfect freedom from all subjective symptoms, although the aural phenomena may become more and more severe, the inflammation, in some cases, even involving the mastoid cells. As a rule, one ear alone is affected in the manner stated.

C. J. Blake³ also reported two cases of *otitis intermittens*, the patients, both males, being subject to malarial fever. In both of them the affection

¹ Monatsschrift für Ohrenheilkunde, No. 11, 1871.

² Deutsche Zeitschrift für Praktische Medicin, 1877.

³ Statistical Report of Sixteen Hundred and Fifty-Two Cases of Diseases of the Ear, treated at the Massachusetts Charitable Eye and Ear Infirmary during the year 1872. By Drs. C. J. Blake and H. L. Shaw. Archives of Otology, vol. iii.

was characterized by pain of a neuralgic type, congestion of the drum-head, and the accumulation of secretion in the drums, the attack being in each case coincident with the general malarial symptoms, and following the course of the febrile movements, both in their increase and in their abatement.

Voltolini's¹ observations on this subject closely resemble those of Weber-Liel, but he emphasizes more strongly the neuralgic symptoms in these cases.

In an article on "Sewer-Gas and Ear-Diseases," J. P. Cassells² records several cases of otitis dependent, he considers, on the poison arising from defective drainage. His observations were made at first among members of his own family,—namely, four of his children. The patients complained of general malaise, and all showed congestion of the naso-pharynx. In one, a boy aged eight years, the aural attack was sudden and painful, necessitating paracentesis of the drum-head followed by a great deal of serous discharge. Two other children were affected in a similar manner, all making a good recovery. In the fourth patient, a girl of three years, great deafness came on at first, but there was no pain. Paracentesis was also made in this case, releasing a quantity of jelly-like mucus. Examination of the premises showed the existence of a choked cess-pool and sewer-gas from bad plumbing in the house. Several other cases similar to those described, coming under this writer's observation, showed immediate and decided improvement when removed from their respective surroundings. The dwellings of all these patients were very damp, and on that account unhealthy. Dampness, so great a factor in the development of all catarrhal affections, had probably therefore much to do with the production of their aural troubles, since convalescence occurred immediately on their removal to more healthy surroundings.

J. O. Green³ published in 1879 the account of a case of intermittent catarrhal inflammation of both ears in a patient, associated with considerable neuralgia about the face and ears. There were intermittent discharge from the ears, constant chills, headaches, and frequently nausea and vomiting. From the general course of the disease he concluded that the case was one of otitis intermittens, caused probably by sewer-gas from defective house-drainage.

A number of observations on the subject of "malarial otitis" have been made by F. C. Hotz,⁴ of Chicago, as to the influence malarial poison occasionally manifests upon the middle ear, in giving rise to an inflammation of a remittent or intermittent nature, or in complicating or modifying an otitis

¹ *Monatsschrift für Ohrenheilkunde*, Mai und Juli, 1878.

² *Edinburgh Medical Journal*, vol. xxiii. part 2, p. 910.

³ *American Journal of Otology*, April, 1879.

⁴ *Archives of Otology*, vol. ix. No. 3, 1880; also, *The American Specialist*, March 1, 1881; also, *Chicago Medical Review*, vol. v. p. 252, 1882; also, *Zeitschrift für Ohrenheilkunde*, Wiesbaden, 1880, vol. ix.

due to some other cause. The cases he reports exhibited certain peculiar features attributed by him to the influence of malarial poison, viz., great nervous prostration, and pains in the head and ears like those seen only in cases of severe purulent inflammation, while the objective symptoms, on the other hand, were those usually observed only in the milder forms of catarrhal otitis media. The history of one of his later cases will be found of interest. The patient, a lady of thirty-six years, had been subject to attacks of intermittent fever, the last one three weeks before the occurrence of the aural disturbance. The latter began with neuralgia of the left side of the head, extending to the left ear and parietal region. This neuralgia came on every morning, grew worse towards noon, and subsided towards evening. The post-auricular and infra-auricular regions became swollen, and the left ear began to discharge. The neuralgic attacks then appeared every second day only, but the swelling about the ear and the pain continued, the deafness being also very considerable. This condition gradually improved under treatment, and the patient eventually recovered.

Further observations have also been made by Descamps,¹ Seely,² Turnbull,³ Pomeroy,⁴ Andrews,⁵ Sexton,⁶ Roosa,⁷ Rossi,⁸ and others, some of whom have recorded interesting cases. Sexton⁹ states that in twenty-six cases of so-called "malarial fever," "chills and fever," "intermittent fever," two were suffering from acute purulent otitis media, two from chronic purulent otitis media, one case with acute catarrhal otitis media, fourteen with chronic catarrhal otitis media, whilst two were afflicted with otalgia, and two more with an otitis externa. In all these patients, he states, the symptoms of autophony and nervous prostration were marked.

The opinions of all authorities on the subject seem to vary, yet the consensus of opinion would appear to be more or less opposed to accepting the rather extreme views of such writers as Weber-Liel, Voltolini, and a few others, that, namely, the manifestations of an otitis occurring in a person subject to malarial attacks and influences are in any way peculiar in themselves. It is generally conceded, however, that the existence of a so-called malarial poison, whether in the form of sewer-gas from defective

¹ Fièvre intermittente se manifestant sous la forme d'une Otite intermittente. Archives Méd. Belges, Bruxelles, 1871, xiii. 89-96.

² Cincinnati Lancet and Clinic, October 6, 1883.

³ Otitis Intermittens, or Malarial Otitis; with Observations on the Use of Quinine in Diseases of the Ear. Transactions of the American Medical Association, Philadelphia, 1881, xxxii. 223-229.

⁴ Affections of the Ear influenced by, or dependent on, Malaria and Defective Drainage. New York Medical Record, January 31, 1885.

⁵ Concerning Malarial Affections of the Ear. New York Medical Record, March 7, 1885.

⁶ The Ear and its Diseases, etc. New York, 1888, p. 69 *et seq.*

⁷ Diseases of the Ear. New York, 1891, seventh edition, p. 323 *et seq.*

⁸ Archives of Otolgy, vol. ix. No. 2.

⁹ Op. cit.

drainage, plumbing, etc., or due to climatic conditions and environments, does exert in numerous instances a modifying influence on the aural disturbance. This may take the form of aggravating the neuralgic pain about the head and ears, or intensifying the tinnitus and general malaise and feeling of debility in the patient, as a perusal of the published records of such cases seems to demonstrate. The fact that the aural troubles appear to have yielded quickly in such cases on the administration of quinine, etc., has led most writers to a belief in their "malarial" origin; and, indeed, it must be admitted that this fact is a potent one, and one which would possibly seem to justify more or less such a conclusion. In such cases, however, we should never lose sight of influences which often surround these patients, and which are well-recognized predisponents and causes of catarrhal conditions of the upper air-passages. The writer alludes here to mental strain from overwork, the worry and dissipations of every kind so frequent especially in our city life; to the overheating of dwellings and public places of amusement, schools, etc., the dampness of these latter in the country, and the greater exposure of persons in country places to climatic changes. All such are potent in their influence not only in the production of catarrhal inflammation, but also in aggravating such a state. Thus, the fever generally present may be ushered in with chills and the tendency to recurrence increased, whilst malaise, depression of spirits, vertigo, etc., are not infrequently present. It is very questionable if, in these cases, the symptoms described have not their origin in a general disturbance of the nervous system due to some of the conditions mentioned. The writer believes that further evidence and observation will be necessary to enlighten us as to the real or imaginary influence of a malarial poison as a factor in the production of a special form of middle-ear disease.

Treatment.—Local treatment by means of applications, wet or dry, seems to have afforded no permanent relief whatever in the cases recorded until supplemented by the administration of quinine. The aural trouble then yielded quickly on the alleviation of the primary affection. Quinine was given by some of these authorities in small doses, frequently repeated, by others in very large doses. Large doses of the drug were indicated when the spleen was increased in size and tender on pressure. The subjective noises and deafness in these cases of so-called malarial otitis were relieved by the administration of large doses of quinine, in strong contrast to the usual forms of middle-ear inflammations, where even small doses of this drug seem to intensify such symptoms. In cases of suspected defective drainage, etc., or where the surroundings of the patient are damp or unhealthy, removal to some healthy, dry location should be carried out as soon as possible. Rest, quiet, and dietary precautions, of course, ought not to be neglected, since they should receive careful attention in all cases where general debility and malaise form such prominent features of the trouble. General tonics would also be indicated, and stimulants when necessity calls for their use.

SYPHILIS.

The difficulty of recognizing the syphilitic element in ear-diseases, and the natural reluctance on the part of the patients themselves to acknowledge having ever contracted the disease, may account largely for the comparatively scant literature on this subject and the rather limited number of cases reported. That such cases, however, are far more frequent than might be supposed from a perusal of such reports may be without doubt accepted as a fact. Thus, for instance, Buck¹ reports having observed but thirty cases of aural disease which could fairly be attributed to syphilis, out of a total of three thousand nine hundred and seventy-six cases seen and treated by him during a period of some eight years, a little over three-quarters of one per cent. Syphilitic diseases of the ear are much less numerous, it is claimed, in the United States than in Europe. Turnbull,² in a recent article, states that in a city of eight hundred and fifteen thousand inhabitants the proportion of cases of syphilitic disease of the ear is about sixteen in one thousand. Examination of the statistical reports of deaf-mute institutions in this country will show the larger proportion of acquired deaf-mutism to be attributed to scarlet, typhus, and other fevers. It is very probable that a large number of such patients, however, owe their condition to congenital syphilis, the true cause not being properly ascertained by the superintendents in charge. As these latter are seldom medical men, such a supposition would not seem altogether unjustifiable.

Of the various forms of syphilitic ear-affections which have been observed and recorded, we shall undertake to describe only those cases of deafness arising from syphilitic infection. Such may be due either to acquired or hereditary syphilis.

Pathology.—Although many have been the writers on affections of the ear occurring along with or in consequence of syphilitic infection, it has not been until a rather recent date that the pathological nature of such aural invasions has been more clearly comprehended. Indeed, it must be admitted that there is, comparatively speaking, very little, even in the present day, that is understood on this subject. There is a great difference of opinion among most investigators, some rather inclining to consider the labyrinth as the seat of the aural affection in syphilitic deafness, whilst many would locate the trouble in the middle ear and its sound-conducting mechanism.

ACQUIRED SYPHILIS.

The early writers in France and England were very vague in their ideas on the subject, referring to cases of syphilitic aural disease as "constitutional deafness." Among such authors the names of Saunders, Curtis, Wright, and Caswell, in England, and Itard, Deleau, and Saissy, in France, should be mentioned.

¹ Syphilitic Affections of the Ear. American Journal of Otolgy, vol. i. p. 25, 1879.

² Deafness the Result of the Poison of Syphilis. Annals of Ophthalmology and Otolgy, vol. i., No. 1, Kansas City, Mo., January, 1892.

"The whole class of the diseases to which the internal part of the ear is subject may be denominated nervous deafness," says Saunders;¹ and further on he states that, being forcibly struck with the congruity between deafness produced by syphilis and the concomitant symptoms of nervous deafness, he could not avoid the conclusion that, although the remote cause is different, the proximate cause is the same in each.

A more elaborate account of syphilitic affections of the ear, perhaps, among earlier writers, is to be found in the work of Wilde of Dublin, published in 1853.² He evidently inclined to the idea of an intra-tympanic seat of the lesion in cases of deafness resulting from syphilis, as may be seen from the following quotation: "Although practitioners who treat syphilitic diseases upon a large scale appear to be aware of the fact that venereal occasionally causes deafness, I cannot find any authority which has noticed the disease I am about to describe. The deafness which sometimes accompanies the secondary form of syphilis is generally believed to be caused by inflammation and ulceration extending from the throat through the Eustachian trumpet into the middle ear; such may, under certain circumstances, no doubt, occur, and produce destructive inflammation and supuration in this cavity, although I have never seen such a case myself, nor have I met with a well-authenticated instance of it recorded." Further on he says, "The disease I am about to describe is an inflammation of a specific character occurring in the membrane of the tympanal cavity, but chiefly exhibited in the external membrane of the drum." Wilde emphasizes also the fact that the disease appeared suddenly in almost every case, was accompanied by vertigo upon stooping and rising up suddenly, and by a sensation of fulness in the head and ear, and furthermore that both ears were usually invaded simultaneously. The amount of deafness in his cases was always very great, this symptom being the first to attract the attention of the patient to his aural affection. Tinnitus was usually absent, says the same author, and pain was never an accompanying symptom.

Since this work of Wilde, there have been numerous contributions to the literature of this subject, but none throwing much light on the pathology of the affection in question. It may be found of interest to glance at the writings of more modern authorities for an estimation of their opinions. The difficulty of relegating the subjective symptoms in these cases to the anatomical region where they naturally belong is one of the greatest barriers to a proper solution of this perplexing problem.

Buck³ holds that it is impossible always to ascertain if the deafness be entirely due to changes effected in the transmitting mechanism of the middle ear, or, if not entirely, still in some measure to an affection of the auditory nerve. He proposes to classify the cases according to their objective and subjective symptoms: in one class, namely, cases in which the patho-

¹ Treatise on the Ear, p. 95. Philadelphia, 1821.

² Practical Observations in Aural Surgery, p. 252. Philadelphia, 1853.

³ American Journal of Otology, vol. i., 1879, p. 25.

logical conditions of the middle ear would account for the deafness of the patient; in another, cases in which the nearly or fully normal condition of the middle ear presents a strong contrast to the degree of loss of hearing-power; and in a third class, cases in which the evidences of pathological changes in the middle ear do not sufficiently account for the marked degree of deafness. Buck designates the first of these classes "syphilitic disease of the middle ear;" the second, "syphilitic disease of the auditory nerve;" the third, "syphilitic disease of the middle ear and auditory nerve."

Of his thirty cases he says that only seven belong in the first of these groups, seven in the second group, whilst eleven are included in the third class. The remaining five cases were of syphilitic lesions of the auricle and external auditory canal. Of the twenty-one patients whose histories are given by him, all but two were male individuals. Although the labyrinth is frequently assumed to be the seat of the syphilitic lesion, it is yet quite possible that the latter may be situated in the middle ear or in the auditory nerve before it enters the labyrinth. Again, as Buck goes on to state, the mucous membrane covering the round window may be so congested and swollen as to give rise to these symptoms of deafness, a condition of things which could not well be observed, since the drum-head would not necessarily indicate such changes by its own appearances, and all other evidence of disease in the middle ear may be absent. Owing to such local swelling and congestion, he concludes that deafness, vertigo, and staggering of gait might easily arise from the pressure thus exerted on the fluid of the labyrinth; and such pressure, furthermore, might soon cause intra-labyrinthine anæmia, followed by a disturbed nutrition of the delicate structure of the cochlea. Insignificant pathological changes in the small passages through which the auditory nerve runs would also suffice to produce disarrangements of the sound-perceptive centre.

Roosa¹ admits that syphilitic affections of the middle ear are probably more common than those of the labyrinth. Such may consist of a syphilitic exudation into the tympanum and about the ossicles. On the other hand, he believes that in some cases a labyrinthine lesion in syphilis affecting the auditory nerve in the cochlea does exist: to this he has given the name of "syphilitic cochlitis."² He states, however, that to differentiate between affections of the tympanum and labyrinth in these cases of syphilitic deafness is extremely difficult,—in most instances, indeed, impossible. Roosa records the histories of eight cases of syphilis showing symptoms of labyrinthine or cochlear disease: of these seven were males, and one a female. He lays down certain conclusions as a guide in determining the situation and character of the lesion in doubtful cases. He remarks that, in the first place, disease of the cochlea, as also of the other parts of the labyrinth, will generally manifest itself suddenly, but that the sudden

¹ Diseases of the Ear. New York, seventh edition, 1891.

² First Congress of the International Otological Society, 1876.

deafness, vertiginous symptoms, and tinnitus have a pathognomonic value only in connection with objective examination tests, and, secondly, that the tuning-fork C_2 is more distinctly perceived through aerial than through osseous conduction. Thirdly, an examination of the drum-head and inflation of the tympanum should demonstrate the existence or non-existence of any exudation into the latter cavity, thus aiding in the diagnosis of middle-ear or labyrinthine disturbance. Fourthly, he adds, we have the piano to assist us in the diagnosis of these cases, the power of perceiving low tones being the last to suffer in cases of labyrinthine affections and the first to recover in most instances of disease of this region: thus, such low tones will be heard when the high ones are not heard at all or are perceived as false or double tones.

In consequence of the intimate connection of the middle ear with the nose and throat, it is more liable than any other part of the auditory apparatus to be invaded in syphilitic disease. "Mucous patches may form in the Eustachian tube or upon the walls of the middle ear, and either disappear under treatment or terminate in ulceration, destroying the tissues to a greater or less extent," says Bumstead.¹

According to Gruber,² these mucous patches when situated upon the mucous surface of the fenestræ or the internal surface of the tympanum are apt to cause great pain, which persists until the ulceration is healed.

Bumstead is rather incredulous as to the value of these statements of Gruber, since, as he remarks, when we recall the inaccessibility to observation of the region said to be affected, their very explicitness cannot but throw a shade of doubt upon their merit. Gruber holds that extension of actual ulceration may take place. According to him, the orifice of the Eustachian tube is, of course, first attacked, but the ulceration may proceed to the destruction of the larger portion of the hearing organ.

Sturgis³ inclines to consider such affections of the middle ear as occurring either independently of any other lesion of syphilis—in other words, idiopathically—or in connection with or by extension from lesions in the throat, such as mucous patches or infiltrations of the mucous membrane.

Hyperæmia has been observed in the vestibule at the entrance of the cochlea and horizontal semicircular canals, in a case of catarrh of the drum, and probably periostitis, in a patient with syphilis.⁴ In another case,⁵ of sudden deafness and tinnitus occurring during the secondary stage of syphilis, the autopsy showed that the middle ear was intact, while sclerosis of the petrous portion of the vestibule and small-cell infiltration of the

¹ Pathology and Treatment of Venereal Diseases, p. 29. Philadelphia, 1883.

² Wiener Med. Presse, 1870, Nos. 1, 3, 6, 10.

³ On the Affections of the Middle Ear during the Early Stages of Syphilis. By F. R. Sturgis. Boston Medical and Surgical Journal, June 3, 1880.

⁴ Gruber. Centralblatt für Chirurgie, August 19, 1877.

⁵ Moos. Lehrbuch, p. 617.

membranous labyrinth, with ankylosis of the membrana secundaria, had taken place.

According to Turnbull,¹ serous catarrh occurs also in syphilis, though less commonly than mucous catarrh, and the exudate has a yellowish-red color. He states, furthermore, that "by a careful examination it will be found that the syphilitic disease affects the most vital portion of the internal ear (the labyrinth), which becomes thickened in its membranous covering, and the fluid which it contains is bloody and increased in quantity." This, he argues, would account for the profound deafness, as would also the changes in the osseous structure, the petrous portion of the temporal bone, containing the delicate sound-perceptive centre. Then, again, the hyperæmic semicircular canals with chalky deposits on their membranous portions, he thinks, might give rise to the staggering gait and tendency to fall, observed in such persons. These are reasons, he holds, for placing the seat of the lesion in such cases in the labyrinth.

At the Seventh International Medical Congress, held in London in 1881, Dr. F. M. Pierce, of Manchester, read a paper on the action of syphilis on the ear. He stated therein that the evidence of syphilis attacking the middle ear pointed mainly to a catarrhal condition, with a marked prevalence of anomalous auditory nerve symptoms, the latter being in adults suggestive of acquired or congenital syphilis as a predisposing cause. He referred to forty cases of acquired syphilis affecting the ear. This author also speaks of the frequency of simultaneous inner-ear symptoms, and queries how, if most syphilitic ear-affections be due to inflammation of the periosteum of the petrous and temporal bones, the rapid loss of auditory nerve power is to be explained.

Opposed to those who favor the labyrinth as the seat of the lesion in these cases of syphilitic deafness are a number of well-known authors. According to C. H. Burnett,² we have "many more reasons for placing these apparently syphilitic changes in the tissues of the middle ear, the conductive functions of which we are acquainted with, than in the labyrinthine and nervous structures, of the mechanism of which physiologists know nothing positive." The well-marked changes in the middle ear caused by syphilis have very erroneously been referred to the nerve-structures of the internal ear, especially to the cochlea, says the same writer.

Burnett³ bases his views largely on the results of investigations of certain authorities concerning the physiology of the cochlea in vertebrates. Noteworthy among these are the experiments of Baginsky performed upon dogs in the Veterinary School in Berlin, and laid before the Academy of Sciences of Berlin in 1883. According to Baginsky, his experiments show "that the point or cupola of the cochlea contains the parts of the nerve concerned in the perception of low notes, while the base of the

¹ *Op. cit.*

² *The Ear, etc.*, p. 389. Philadelphia, second edition, 1884.

³ *Philadelphia Medical Times*, October 6, 1883.

cochlea, near the round window and the promontory, contains the portions of the nerve concerned in hearing high notes." From this supposition Burnett deduces certain points in relation to sound-conduction and sound-perception. Since the experiments go to show that the parts of the internal ear best adapted to the perception of high notes, as for instance the human voice, are not only in the cochlea, but also in that part of the latter lying nearest the promontory and round window, they are therefore situated where sound-waves would be most likely to reach them directly. "For it is a physical fact," says Burnett, "that when sound falls on the membrana tympani some of it passes directly through the membrane, and across the tympanic cavity, and strikes upon the membrane of the round window and upon the promontory. Sound taking such a course would thus act almost directly upon the terminal nerve-fibres in the cochlea, without pursuing the more roundabout way through the oscillations of the chain of auditory ossicles."

The experiments of C. J. Blake¹ with König's rods go also to prove that the nerves situated near the promontory and round window are concerned in the perception of high notes. When, therefore, the passage of sound-waves to the drum-cavity or to the membrane of the round window and promontory is obstructed, as in swelling of the tympanic mucous membrane near these parts in attacks of acute catarrhal inflammation, etc., the first damage to the hearing-power is observed in connection with the higher and more delicate tones of the human voice.

From his investigations in regard to the diagnostic value of the tuning-fork in the differentiation of aural disease, Sexton² concluded that this instrument had but little if any importance in this respect. Burnett, in reflecting upon these investigations of Sexton, considers that the phenomena observed when placing the vibrating tuning-fork on the vertex, glabella, or teeth, in individuals with or without normal ear or ears, have been misunderstood, and consequently misapplied in diagnosis, giving rise to false conclusions. "The chief error," he states, "lies in considering the results obtained by its use as data for estimating the *perceptive* power of the nerves, rather than the *conducting* power of the auditory apparatus in the external and middle ear." Hence many writers have overlooked the more obvious explanation of phenomena in hearing the tuning-fork, offered by the changes in the tympanum or its contents, while seeking "for an explanation of the morbid phenomena of audition in the more remote and less understood internal ear." The endeavor, therefore, to establish the existence of a "cochlitis" from the occurrence of certain acoustic phenomena would seem somewhat illogical and unscientific, Burnett argues, since such phenomena could easily be called forth by altered conduction owing to changes in the mucous membrane of the tympanum. The fact, moreover,

¹ Transactions of the American Otological Society, 1872.

² The Significance of the Transmission of Sound to the Ear through the Tissues in Aural Disease. Transactions of the American Otological Society, 1883.

that sudden loss of hearing in a syphilitic patient has been cured by anti-syphilitic measures would by no means be a proof that the seat of disease was the cochlea and the deafness due to a "syphilitic cochlitis."

An elaborate article by Sexton¹ appeared in 1879, giving a clear, concise account of his views as to the nature of the disease and the region affected in these cases of deafness resulting from syphilis. He states that "a step forward has certainly been taken in removing from the list of nervous affections of the labyrinth diseases whose symptoms now clearly establish their identity with anomalies of the conductive apparatus of the middle ear. Of the primary and secondary diseases of the acoustic nerve, or of the labyrinth and its bony core, we know but little, and can, therefore, place but little value on observations made with the belief that such knowledge exists." Sexton considers that the attacks of syphilis have many symptoms in common with those of subacute catarrhal inflammation of the middle ear, but that the ordinary catarrhal otitis media is never accompanied by pathological conditions causing the sudden and profound deafness which syphilis produces. He believes, moreover, that the frequency of the affection is much greater than generally suspected, and that many such cases become classified under the head of diseases of the labyrinth. He does not consider the probability of syphilitic invasion *via* the Eustachian tube by extension from the pharynx as very great, but believes that the attack arises in the ear itself. Sexton reported four cases in this article, and three more in a later paper² on the same subject. Of these, six patients were males and one female. He states that in none of them were the throat-symptoms very prominent nor even the Eustachian tubes obstructed. Bumstead is inclined to adopt the views of Sexton, in whose opinion granuloma, or circumscribed round-cell infiltration, takes place, especially in the more severe cases, within the tympanic cavity. Such invasions are usually rapid, and would interfere with the movements of the sound-transmitting apparatus. According to the same author, a rapid deposition of lymph taking place causes fixation of the chain of ossicles, and consequent deafness.

The following are the conclusions of Sexton in regard to these cases, and seem reasonable and well founded: "1. Syphilitic affections of the ear inducing sudden deafness are of exceptional occurrence. 2. They would seem to be induced by a pre-existing hyperæmia in the ears, excited by sympathetic relationship or by an intercurrent attack of aural mucous catarrh. 3. The attacks are characterized by their sudden occurrence, and both ears are usually affected simultaneously, although the contrary sometimes takes place. 4. The deafness is always very great. 5. This syphilitic affection causes a disarrangement of the integrity of the chain of ossicles, most likely at the malleo-incudal joint, probably in some instances at the stapedo-incudal joint, or both of these. The movements of the stapes in the oval

¹ The Sudden Deafness of Syphilis, with Cases. American Journal of the Medical Sciences, July, 1879.

² American Journal of Otology, vol. ii. p. 301, October, 1880.

window are also likely to be interfered with. The two first-mentioned conditions serve to explain the noises in the ears, and the autophony; the last-mentioned condition would increase the anomalies of hearing. 6. The affection does not depend, so far as we know, on anomalies of any portion of the labyrinth, although the latter, of course, is liable to invasions from syphilis with the nature of which we are as yet unfamiliar. 7. The disease is usually unattended by pain in the ears; it is non-purulent, and its incurability is a characteristic."

HEREDITARY SYPHILIS.

Although perhaps the greater number of cases of syphilitic disease of the ear coming under treatment will be found to have followed an attack of acquired syphilis, it is not of infrequent occurrence to observe cases where the causative element is congenital. A considerable number of such instances have been recorded by various writers. Hutchinson¹ has written an elaborate essay on the diseases of the eye and ear in inherited syphilis, wherein he states that deafness occurred in fifteen out of one hundred and two cases of syphilitic keratitis.

Pierce² states that congenital syphilis manifested itself in his cases from the eleventh to the eighteenth year on the average, that it was more frequent in females than in males, about four to one, and that the access of deafness was gradual but rapid, usually in from three weeks' time to one year, about the period of puberty in women and rather later in men. The deafness in his cases was generally preceded by specific chronic interstitial keratitis, recovery from which gave the signal for the accession of very intractable, extreme deafness. He refers to thirty-five cases coming under his observation.

In two patients (both females) observed by Duncanson,³ the ears became involved at about the age of puberty, the deafness coming on gradually and showing an increase after the affection of the eyes had become stationary. In another case, that of a young man, neither myringotomy nor myringectomy afforded any relief for the deafness.

Aural affections consequent on hereditary syphilis have been described by Schwartze,⁴ von Troeltsch,⁵ Pagenstecher,⁶ Hinton,⁷ Wreden,⁸ and others. An elaborate and interesting article on this subject, by Knapp,⁹ appeared in

¹ A Clinical Memoir on Certain Diseases of the Eye and Ear consequent on Inherited Syphilis. By Jonathan Hutchinson.

² Op. cit.

³ Report of One Hundred Cases of Diseases of the Ear. By J. J. Kirk Duncanson. Edinburgh, 1878.

⁴ Archiv für Ohrenheilkunde, Bd. iv. S. 258, 1869.

⁵ Lehrbuch der Ohrenheilkunde. Virchow's Archiv, Bd. xvii. S. 19, Case V.

⁶ Deutsche Klinik, 1863, 41-43.

⁷ Clinical Remarks on Perforation and some other Morbid Conditions of the Membrana Tympani. Supplement to Toynbee's Text-Book, p. 461. London, 1868.

⁸ Monatsschrift für Ohrenheilkunde, 1869, Nov. S. 169.

⁹ Archives of Otology, 1880, vol. ix. p. 146.

1880, in which are given in detail the histories of two cases of heredito-syphilitic otitis, both patients being females. The deafness was in both instances more or less rapid, in the one, however, less sudden than in the other. In the one case, he states, symptoms plainly showed that both the middle and internal ears participated in the affection. In the middle ear a catarrhal inflammation was unmistakable from the presence of marked physical changes. These were, however, not extensive enough to account for the high degree of deafness. An implication of the labyrinth had to be assumed, even if the positive symptoms of it had been absent. These symptoms, well known under the name of Ménière's disease, were headache, nausea, vomiting, dizziness, staggering gait, tendency to fall. One symptom only, tinnitus aurium, was not complained of. Under treatment this patient made a permanent recovery, with perfect restoration of hearing. In the other case the symptoms pointed to mild otitis media catarrhalis, and also to a marked affection of the labyrinth. In this case the deafness persisted in spite of treatment, a fact which the writer considered due in a great measure probably to the bad hygienic conditions under which the child lived, in comparison with the much better surroundings of the first patient. Respecting most of the cases seen by Knapp, this author states that the preponderance of the labyrinthine symptoms over those of the catarrhal otitis media was characteristic.

Kipp¹ reported the histories of six cases, all of whom were females, ranging in age from six to twenty-three years. In five of them the aural invasion was preceded by parenchymatous keratitis. In all of these cases tinnitus aurium, headache, vertigo, and staggering accompanied or followed the attack, and the loss of hearing was very sudden in five, in the sixth more gradual. In none was there any pain accompanying the attacks, and the Eustachian tubes were permeable in all of them. Kipp states that the appearance of the drum-heads in four of his subjects made it seem probable that the deafness was partially due to catarrhal otitis media, although the latter could hardly account, in his estimation, for the great amount of deafness. He considered, therefore, that an affection of the labyrinth or acoustic nerve existed in these cases. Kipp is inclined, moreover, to the assumption of a lesion in the floor of the fourth ventricle, from which both nerves arise, as this might account for the simultaneous loss of hearing in both ears.

Buck² reported a case of congenital syphilitic ear-disease in a male child, producing rapid and profound deafness in both ears. Treatment was followed by great improvement in the hearing-power. Buck inclines to the opinion that a localized periosteitis of the inner wall of the cochlea or of the stapedo-vestibular articulation is the lesion on which the deafness

¹ On the Ear-Affections of Inherited Syphilis. Transactions of the American Otolological Society, 1875, vol. ii, Part I. page 390.

² New York Medical Record, October 1, 1887; also, Manual of Diseases of the Ear, p. 362. New York, 1889.

depends in these cases. When hearing is restored under treatment, he argues that the delicate structures of the cochlea have probably not been seriously disturbed in their relations. Should these structures be greatly affected, as is usually the case in attacks of syphilitic deafness, it would seem hardly possible that they could again be capable of performing their delicate and precise task. This view of the subject has undoubtedly much in its favor, and, coming from so well-known a source, merits every consideration.

From the foregoing statements and conclusions of various writers, it is apparent that a very vague idea really exists as to the pathological nature of the affection under consideration.

There appears, however, no especially strong reason for holding the inner ear responsible as the seat of lesion in such cases, since all the phenomena accompanying these attacks could easily result from an affection of the middle ear and interference with its transmitting mechanism, —an opinion the writer is inclined to share with Burnett and Sexton, unless indeed a post-mortem examination should actually demonstrate the existence of labyrinthine disease.

Further research and investigation, it is to be hoped, will eventually clear up the doubtful points at issue.

Subjective Symptoms and Course.—It is in the secondary stage of acquired syphilitic infection that aural complications are mostly met with, and in inherited syphilis usually some years after birth. Such attacks are rarely of a purulent character, although they do, in some instances, go on to suppuration. Gruber states that if the ulcerative process, which he holds takes place in certain cases, be confined to the Eustachian tube, simple hardness of hearing results, with abnormal sounds, and the sensation of tension or fulness. When, however, invasion of the middle ear occurs, severe pain sometimes ensues, and the drum-membrane loses its brilliancy and becomes uneven and injected. The question of pain in these attacks seems to be also one regarding which a difference of opinion obtains. Thus, Sexton states that the syphilitic affection of the ears had not been found to be painful, but distressing on account of the severe tinnitus and autophony usually present. All otologists know that such phenomena as these are frequently called "pain" by the patients themselves, and a careful examination alone will make a differential diagnosis possible.

Pierce, in his paper before referred to, observes that absence of pain is characteristic of such attacks of syphilitic ear-disease in both acquired and congenital syphilis.

Sturgis,¹ however, mentions the fact that pain is the first symptom to attract the patient's attention. This pain is not often severe, but comes on in twinges, usually at night, and has a marked periodicity. The mani-

¹ On the Affections of the Middle Ear during the Early Stages of Syphilis. By F. R. Sturgis. Boston Medical and Surgical Journal, June 3, 1880.

festations of this nocturnal pain he considers to be of great diagnostic importance, as sometimes the otitis media does not develop until after the disappearance of the skin eruptions, etc., during the period of repose following the eruptive stage. It seems probable, however, that pain is not always an accompanying feature in such attacks; in fact, it may be said to be rarely present unless arising from other sources, such as decayed teeth, etc. A sense of pressure or fulness often accompanies the attack, and the patient will not infrequently experience more or less vertiginous phenomena when stooping over or rising suddenly. Noises in the head and ears, more or less intense, are also generally present, and these phenomena are not infrequently accompanied by autophony. The high pitch of sounds is also a feature in these cases. Thus, for example, the notes of a violin resting on the neck of the patient will be heard as much higher than they actually are. The rumbling of trains or wagons in the streets produces very high-pitched and painful sounds like locomotive whistles, etc.

The most prominent symptom, however, and one which, as a rule, brings the patient to the physician's notice, is the *sudden and great deafness* in one or both ears. In fact, it is this sudden and oftentimes profound deafness that makes these cases so marked and calls for our special attention and treatment. There is no other disease of the ear which is followed by such rapid and absolute deafness. According to Sexton,¹ both ears become affected generally at the same time, but not necessarily in the same degree, and he states that in none of the cases coming under his observation has either ear altogether escaped the attack. These invasions of sudden deafness are liable to occur at any period of the secondary stage of syphilis, but are usually met with during the first three or four years after specific infection. As a rule, such an attack of the organ of hearing will be directly following a state of hyperæmia of the tympanic cavities, induced by a cold either in the head or in the ears, the parts being thus rendered more susceptible to the specific invasion.

Objective Symptoms and Diagnosis.—When a case of syphilitic deafness comes under our observation, the anatomical appearances of the ear will rarely afford any assistance to a diagnosis, for all writers agree pretty well that lesions characteristic of syphilis are never observed in the middle ear or the membrana tympani. Frequently, however, the inner end of the external auditory meatus will be found slightly reddened and congested, and the drum-head itself thickened in appearance, opaque, dull, and often retracted. The latter is especially the case where the Eustachian tubes are swollen or closed, and experiment has shown that the drum-cavities generally contain no fluid. Cicatrices in the pharynx about the mouths of the Eustachian tubes and other sequelæ in this neighborhood would aid in establishing a correct diagnosis in cases of acquired syphilis. Of course, should the deafness be accompanied by loss of perception of sound through

¹ The Ear and its Diseases, p. 257. New York, 1888.

the bones of the cranium, it would seem fairly warrantable to consider the case one of labyrinthine syphilis. When external sounds are not perceived, but autophony exists, it would appear probable that the seat of the lesion is in the sound-conductive apparatus of the middle ear, since otherwise it would be difficult to understand how patients could hear their own voices were the sound-perceptive centre the seat of disease. In cases of hereditary congenital syphilis an examination of the parental history will be, of course, necessary. The existence of infiltrated glands about the ear, and other symptoms of syphilitic lesions, would also aid us very materially in a diagnosis.

Prognosis.—In the less severe cases of syphilitic deafness the prognosis is not hopeless, under proper care and treatment, as experience has proved; and this may be said especially in regard to cases where the trouble is of hereditary origin. With great circumspection and perseverance we may obtain fairly satisfactory results, a demonstration of which is afforded in Knapp's case, already referred to. As a rule, however, and especially in cases of very rapid and profound deafness, the prognosis is decidedly bad as far as the restoration of the hearing-power is concerned, little if any improvement ever resulting from treatment.

Treatment.—All writers agree practically as to the uselessness of any local treatment in these cases of syphilitic deafness, excepting, perhaps, the occasional use of Politzer's air-douche. Treatment should be constitutional in all cases, with as much care to hygienic conditions and surroundings as possible. Mercury in the form of calomel or corrosive sublimate in small doses is given, sometimes together with the iodide of potassium. Buck¹ has proposed the iodide of potassium given in very large doses several times a day, and reports beneficial results from its use. Sexton advises the use of the biniodide of mercury in doses of one-fiftieth of a grain three or four times daily, and is rather opposed to excessive doses of the iodide of potassium. He states that from three to five grains of the iodide in connection with one-thirtieth of a grain or less of the bichloride of mercury have given the best results in his own experience. Sexton's views in this respect are based on the result of treatment in one hundred and eighteen cases.² Wolff³ also strongly urges the use of mercury in connection with the iodide of potassium. Bumstead advises the administration of very large doses of the iodide of potassium internally, together with mercurial inunctions. In his estimation they give some promise of relief, and, possibly, of a cure. Even should the patient come under treatment after the trouble has existed for a considerable time, Bumstead advises their application. Turnbull, in his article already referred to, goes quite extensively into the treatment of these cases, and recommends hypodermic injections of bi-

¹ New York Medical Record, Sept. 6, 1884.

² The Ear and its Diseases, p. 258. New York, 1888.

³ Ueber Syphilis hereditaria tarda. Volkmann's Sammlung, No. 273.

chloride of mercury, or the biniodide compound solution or biniodide pills, as constitutional measures. Red iodide of mercury in doses of one-seventh grain to the tablespoonful, with seven and three-quarter grains of potassium iodide, three times daily, is also employed by him. In cases of hereditary syphilitic affection in children or young persons a careful trial should be made with the mercurials, in the form of calomel, hydrargyrum cum creta, or inunctions of oleate of mercury or simple mercurial ointment, with syrup of iodide of iron as a tonic. Turnbull also advises the administration of pyrophosphate of iron and arsenic in combination with the mercury, as a preventive of irritation to the rectum.

The last-mentioned author experimented in cases of profound deafness with pilocarpine injections, following the lead of Politzer, who, some ten years since, introduced and successfully applied the active principle of *jaborandi* in a case of syphilitic deafness. Politzer,¹ and after him Moos,² also treated cases of acute and chronic disease of the labyrinth of a non-specific character, with daily injections of two to six drops of a two per cent. solution of the muriate of pilocarpine, the depressing cardiac effects being combated by two drops of a solution of sulphate of atropine (gr. $\frac{1}{2}$ to two drachms of distilled water). Turnbull seems to have met with fair success in his experiments, and the improvement in some cases is noteworthy. S. MacCuen Smith³ reported in 1891 forty-seven cases of greater or less impairment of hearing, some amounting to nearly total deafness, which he treated by this method. Of these, thirty-three received marked relief, seven showed slight improvement, four were not benefited at all, whilst the result of treatment was not recorded in three cases. Field⁴ has also reported beneficial results from this treatment. Turnbull states that he is "gratified if the patient, after treatment with pilocarpine for weeks and months, is able to hear the human voice in ordinary conversation, and a watch which measures sixty inches—say ten to twenty, or even thirty inches." The remedy has been found of benefit also in labyrinthine deafness from locomotor ataxia and in the total deafness after mumps.

Treatment should begin with small doses of the drug, increasing them gradually. He employs it every other night in the form of a hypodermic injection, and prescribes a tablet of gr. $\frac{1}{150}$ of sulphate of atropine when cardiac depression follows the use of the pilocarpine.

GOUTY AND RHEUMATIC DISEASE.

As early as 1849, W. Harvey⁵ read before the Medical Society of London a paper on the rheumatic diseases of the ear, his attention having

¹ Allgemeine Wiener Med. Zeitung, Jan. 20, 1884.

² Archives of Otology, vol. xiii., Nos. 3, 4, 1884.

³ Transactions of the Philadelphia County Medical Society, June, 1891.

⁴ British Medical Journal, April, 1890.

⁵ London Medical Gazette, Oct. 1849.

been first directed to the subject by observing the effect of rheumatic inflammation on the tissues of the eye. He had also noticed, in numerous cases coming under his care, the presence of articular rheumatism influencing directly or indirectly the aural trouble, inasmuch as relief of the one was generally followed by aggravation of the other. He considered that in many such cases treatment resulted in aggravating the aural disease, owing to its true nature being unrecognized. An investigation of the subject enabled him, therefore, to trace in a great number of instances the connection of the ear-affection with a rheumatic condition of the general system. Harvey found that, in contrast to such affections of the eye, those of the ear in rheumatism developed early in the attack of the general system, the fibrous tissues being, as a rule, those first involved, and subsequently the nervous structures.

A rheumatic, gouty diathesis has undoubtedly much to do with the obstinate character of many cases of middle-ear trouble, especially the chronic middle-ear catarrh and the serous form of the disease. The well-known predilection of rheumatic and gouty inflammation for fibrous tissues would seem to be a sufficient explanation of the occurrence of such affections of the middle-ear tissues during attacks of gout or rheumatism of the general system. Harvey states that the disease exhibited itself under two forms, namely, as an acute and destructive inflammation and as a chronic and insidious affection. Impairment of hearing resulted, if great care was not exercised, in both forms of the trouble. The acute form often led to entire destruction of the organ, generally attacked males, and was associated with articular rheumatism. The chronic form, he states, occurred more frequently in female subjects, being associated especially with muscular rheumatism. In regard to the acute form of the disease, Harvey says that the attacks are paroxysmal, generally following a seizure of articular rheumatism; tinnitus aurium and a sense of numbness about the ear are also present. Exfoliation of bone in the temporal and mastoid regions is likely to occur if the disease be not speedily relieved. In one case, that of a strong, robust man, in whom the attack followed the subsidence of a severe rheumatic articular affection, the left ear became suddenly the seat of great pain, accompanied by a benumbed sensation over the entire periauricular region of the head and distressing tinnitus. Pain and tenderness over the mastoid region followed, and an incision eventually gave relief. The patient improved slowly under treatment, but the deafness did not disappear entirely until some twelve months had elapsed.

Another case reported by Harvey was very similar to the one just described, but resulted in exfoliation of bone and destruction of the ear. A third case was complicated with cardiac inflammation, ending fatally, little benefit to the ear up to the time of death having resulted from treatment.

According to Sexton,¹ the serous form of otitis media is found nearly

¹ *The Ear and its Diseases*, p. 247. New York, 1888.

always in subjects exhibiting a well-pronounced rheumatic or gouty diathesis. He considers it mostly an affection of advanced life, drawing his conclusions from records of twenty-five cases, of whom sixteen were males and nine females. The oldest patient among this number was sixty-seven years of age, the youngest fifteen. There were nine patients between twenty and thirty, eight between thirty and forty, and six between forty and fifty years of age. The same author remarks,¹ furthermore, that he has observed a certain class of patients in whom the aural trouble shows itself by considerable redness of the drum-head, some deafness, and a feeling of stuffiness in the ear, pain, however, being absent. Such attacks of ear-disease occur mostly among persons from thirty-five to forty years of age, and not infrequently among individuals subject to rheumatism.

Other observations concerning the influence of a gouty and rheumatic diathesis in the causation of aural affections were reported by S. O. Richey, at the Ninth International Medical Congress in Washington, September, 1887.² He considers that the minute joints of the ossicula auditus are apparently very liable to an attack of rheumatoid arthritis from their exposure to atmospheric changes.

The deafness so very frequent in boiler-makers, ship-calkers, and locomotive engineers may thus be more easily accounted for, since arthritis deformans closely resembles nervous exhaustion and aural atrophy or progressive deafness. The name general atrophy of the conducting apparatus of the ear describes the result of the process as seen, according to Richey, and he desires to demonstrate its probable neurotic origin in the spinal system by its similarity to a more general affection having its source there. He considers that atrophic degeneration of the conducting apparatus of the ear may not be, to a great extent, inflammatory in any part of its course, nor pre-eminently local in its character; but it is influenced by constitutional dyscrasia, beginning probably at the cervico-spinal nervous centres, and propagated through the sympathetic nervous system or by means of the sensory spinal nerves, thus interfering with local trophic action. This aural atrophy would be rarely recognized before the age of thirty, at which time the function of the ear shows the impairment found in the advanced stage of atrophy.

From the foregoing views of various writers on this interesting subject, it is apparent that only very vague ideas exist concerning the pathology of these affections. The pathological features of such cases, however, are doubtless much more extensive than might naturally be inferred from the limited number of published statements contained in the literature of aural diseases. It is highly probable that among the large number of middle-ear affections coming under observation there are many in which a gouty or rheumatic diathesis not only acts as a causative factor, but also

¹ New York Medical Record, November 3, 1883.

² "Is General Atrophy of the Conducting Apparatus of the Ear identical with Progressive Arthritis Deformans?"

exercises a greater or lesser modifying influence on the course of the disease itself.

Treatment.—The treatment of such cases of aural trouble, where a gouty or rheumatic dyscrasia is suspected or known, should, of course, be directed mainly to the diathetic trouble, and such local measures applied as may be found necessary. Harvey extols the use of colchicum internally, in small and frequently-repeated doses, in chronic affections of the ear presumed to have arisen from rheumatism. He advises the use of the wine of the seeds internally, and the acetous extract as an external application.

DENTAL DISEASES.

The subject of dental irritation in its effect upon the ear in causing and influencing the course of diseases of this delicate organ, is one which has excited much interest and considerable investigation among the more progressive aural surgeons of the day. On the other hand, it should be stated that many otologists and most practitioners of our profession have failed to give the subject the attention it deserves, and also to recognize the importance of oral irritation in the therapeutics of ear-diseases. When we consider the sympathetic nervous relationship existing between the ears and the mouth and teeth, it is not difficult to perceive that irritation from the latter would be a constant menace to the organs of hearing. The nervous sympathy between other parts of the body and the ears has indeed long been known, and the influence exercised by diseases of such on the latter organs has been frequently observed and described in the older text-books. The fact, moreover, that under certain conditions of the system, irritation of the ear in various ways, such as the introduction of instruments into the external auditory canal, etc., will excite various reflex phenomena, as sneezing, coughing, and an impulse to swallow, has also long been recognized. This is a matter easy to understand when we consider the anatomical relationship of these parts through their nervous connections. That dentition, the difficult eruption of the wisdom-teeth especially, the existence of decayed or otherwise diseased teeth, the wearing of badly-fitting artificial dental plates, etc., should frequently excite a reflex disturbance in the organs of hearing, is therefore not difficult to explain.

In 1856, Rau¹ called attention to the fact that dentition in young children generally caused more or less irritation in the external auditory canal, and such writers as Sexton² and C. H. Burnett³ have published the results of their careful observations concerning the effects of oral irritation on the ear, in several elaborate articles.

Woakes⁴ emphasized strongly the importance of an early recognition

¹ *Ohrenheilkunde*, p. 158. Berlin, 1856.

² *American Journal of the Medical Sciences*, January, 1880; also, *The Ear and its Diseases*, chapter vii. New York, 1888.

³ *The Ear*, etc., pp. 89 and 455. Philadelphia, 1884, second edition.

⁴ *On Deafness, Giddiness, and Noises in the Head*. By Edward Woakes, M.D. Second edition, Philadelphia, 1880.

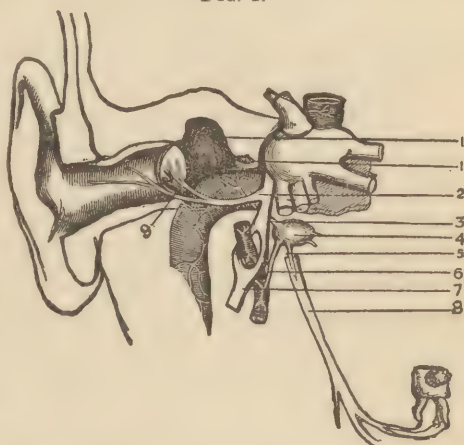
of earache in infants, excited by reflex irritation due to teething. Such pain in the ear would, if recognized early enough, be quickly relieved, in most cases, by a free incision into the gums. It happens, however, very often, according to this writer, that the congestion in the deeper-seated tissues of the ear goes on to suppuration before the aural trouble becomes apparent. The danger of not recognizing the aural symptoms in such cases, says Woakes, is very great, since invasion of the brain is extremely liable to occur, a circumstance easily explained by the intimate relation between the tympanic and cranial cavities in infants.

The accompanying diagram, taken from Woakes's book, shows very clearly the nerve-connection between the ear and the teeth, gums, etc. This author explains the excitation of aural disturbances due to dentition or to diseases of the teeth and gums, not only through continuity of the sensori-motor nerve fibres, but also through vaso-motor nervous connection.

It will be well to glance at the anatomy of this nervous relationship between the ears and the pharynx, nose, and mouth, in order that the reader may better appreciate the importance of the subject.

The nerves composing the group now called the tympanic plexus are brought into intimate relations with those of the throat, mouth, etc., through branches arising mostly from the otic, petrosal, and sphenopalatine (Meckel's) ganglia. By means of the otic ganglion the inferior maxillary or third division of the fifth pair is connected with the plexus, while from the petrosal ganglion of the glosso-pharyngeal nerve arises the tympanic or Jacobson's nerve, which constitutes the largest portion of the tympanic nerve-supply. Connection between the tympanic plexus and the second division or superior maxillary branch of the fifth pair exists also by means of the Vidian nerve through the sphenopalatine ganglion. The carotid plexus of the sympathetic, furthermore, is connected with the glosso-pharyngeal by means of the small carotico-tympanic branches of Jacobson's nerve; communication between the ear and the superior cervical ganglion of the sympathetic is thus established. There are also a number of other smaller nervous connections, for a study of which the reader should consult the text-books on the anatomy of these parts.

FIG. 1.



NERVOUS CONNECTION BETWEEN THE TEETH AND THE EAR (Woakes).—1, tympanic cavity; 2, auricular branch of auriculo-temporal nerve; 3, branch from the ganglion furnishing vascular nerves to the internal carotid artery and its branch the tympanic artery; 4, otic ganglion; 5, branch from otic ganglion joining inferior dental nerve; 6, middle meningeal artery; 7, auriculo-temporal nerve; 8, inferior dental nerve to teeth and gums; 9, short tympanic branch of internal carotid artery.

Owing to these intricate nervous connections, the ear is brought into sympathetic relationship with disturbances arising in various organs of the body, such as the heart, stomach, genito-urinary system, brain, etc. Furthermore, the teeth, the soft palate, and the membrane lining the oral, nasal, and pharyngeal cavities, are thereby in direct relationship with the drum-head, the tensor tympani muscle, the lining membrane of the tympanic cavity, and the external auditory canal.

It is well known that where diseased conditions have long existed, the nerve-tension will become disturbed and reflex phenomena be easily excited. Thus, irritation from long-standing pharyngeal, nasal, or dental trouble is liable to affect some other part, causing nutritive or trophic changes to take place. In this way progressive catarrh of the middle ear, with consequent deafness, may be produced, so slowly, indeed, as to be hardly perceptible to the patient. The delicate mucous membrane lining the cavity of the tympanum, owing to its rich supply of blood-vessels and sensory nerves, is peculiarly subject to such structural changes.

According to Sexton, the eruption and decay of the teeth, aside from the local irritation in the gums arising therefrom, frequently cause sympathetic aural disturbance in children of low vitality. This latter is likely to occur from the time the two central incisors of the lower jaw, usually cut about the seventh month, appear, and may continue until the completion of first dentition, about the end of the second year. The extremely fragile deciduous teeth in such children, and the shells of these temporary teeth, often found embedded in the gums long after their roots have been absorbed, are also frequent causes of sympathetic aural irritation. Examination of the ears in these little patients will often show more or less hyperæmia of the drum membranes, and not infrequently a purulent process of the drum is established, followed by more or less deafness. During the stage of second dentition, beginning about the end of the fifth or the commencement of the seventh year, irritation of the ears is also extremely likely to take place. These permanent teeth are also, like the temporary ones, much disposed to caries as soon as they make their appearance, and this applies especially to the first or "six-year" molars, the eruption of which usually gives rise to much disturbance in the jaw and ears. Many cases, furthermore, are seen where second dentition will again call into activity aural troubles which, caused by the advent of the temporary teeth, had either become entirely cured or at least quiescent. It should not be forgotten that at this period the strain from mental overwork and worry in the child, undergoing now the first rudimentary training of the school-room, has an important bearing on the whole condition and constitution of the patient; the nervous exhaustion consequent on the constant irritation in the jaws renders the patient most susceptible to invasions of acute catarrhal affections.

The cutting of the so-called wisdom teeth, or third molars, constitutes third dentition, and occurs usually between the sixteenth and eighteenth

years, although their appearance is not infrequently delayed until a number of years later. It is not unusual to witness great and general disturbance arising from and during the cutting of the wisdom teeth, and Cooper¹ has directed especial attention to the subject in a highly instructive article. Abscesses in the gums, and even necrosis of the jaw-bone, attacks of tonsillitis and pharyngitis, and some of the most intractable cases of middle-ear inflammation are seen at this period, the latter not infrequently leading ultimately to more or less loss of hearing. Although dentition has undoubtedly much to do in the causation of chronic catarrhal inflammation of the middle ear, owing to the sensitive condition of this organ during the different stages of teething, yet it is probable that the long-continued protracted reflex irritation, due to a diseased state of the teeth themselves, is a much greater factor in the production of this form of aural trouble. The etiology in many cases of middle-ear catarrh is singularly obscure, and an examination of the condition of the teeth and mouth in such cases should never be neglected, even if all symptoms of pain in the teeth be absent, as seen in numerous instances of well-advanced dental decay.

In a review of the records of some eighteen hundred cases of ear-disease coming under his observation, Sexton found that fully one-third of them originated in or were more or less prolonged by a diseased condition of the teeth, and in most instances the aural affections were especially severe. The male sex was somewhat in excess of the female, though not much, and in both men and women the greatest number were affected between the twenty-first and fortieth years. It is interesting to note that the chronic aural affections greatly exceeded in number the acute forms; for example, there were 688 cases of chronic catarrhal otitis media against 126 cases of the acute and subacute form, and 427 cases of chronic purulent middle-ear inflammation against 239 of the acute or subacute variety. In these cases the presence of dead teeth, concealed roots, left either on extraction or after decay of the rest of the tooth, was always ascertained, and their damaging effect on the condition of the gums, nose, and throat, as well as on the ears, carefully noted.

Among other causes of irritation from dental sources mention should be made of the various artificial means of preserving the teeth when decayed, or of replacing them by false ones. Of the numerous substances used for filling the cavities in decayed teeth, the amalgam composed of about two parts of tin and one of silver, with mercury enough to cause adherence of the mass, is by far the most harmful in its results. This mercury is frequently set free, owing to oxidation of the mass, from exposure and friction of the mouth in mastication, movement of the tongue, cheeks, etc., and is, therefore, likely to produce toxic effects. Cavities in carious teeth are often insufficiently cleansed of decayed matter before fillings are intro-

¹ Clinical Lectures upon Inflammation and other Diseases of the Ear, p. 99 *et seq.* London, 1878.

duced, and are thus sources of constant pain and irritation. Again, the mounting of artificial crowns on the roots of teeth, partially destroyed from various causes, is to be deprecated as a dangerous source of irritation.

The habit of wearing artificial plates in the mouth is so general that the possibility of a pernicious effect from their use cannot fail to be of interest to many persons. That such should be the case where these plates are badly fitting, or where injurious material is used in their construction, will be easily comprehended by any one giving a little attention to the subject. Such plates are frequently kept continuously day and night in the mouths of persons who exercise no care or cleanliness in their use, in consequence of which secretions and decomposed food-particles collect under them and are allowed to remain. Again, plates, often ill fitting, are introduced over fangs of decayed teeth, inflamed gums, etc., all of which tends to increase the irritation in the mouth already existing.

The vulcanite so frequently employed in the construction of dental plates consists of caoutchouc, the sulphur used in the vulcanizing process, and vermilion, or the sulphide of mercury, as a coloring-material. When this substance is chewed for several hours before having undergone the vulcanizing process, it parts with the vermilion, and the saliva of persons thus chewing it will show the presence of a mercury salt when treated with a proper reagent. The vulcanite is, moreover, a non-conductor of heat, and, therefore, very liable to excite a hyperæmic and congested state of the mucous surface covered by it. Plates of gold, silver, platinum, and other material are not apt to be so injurious to the mouth and consequently to the ears,—a fact owing not only to their composition, but also to the greater care and labor used in their construction and fit. In a table of cases recorded by Sexton,¹ it is interesting to note that among one hundred and eighty-nine patients wearing badly-fitting dental plates, all of whom were suffering from reflex aural diseases, one hundred and seventy-eight wore plates composed of vulcanite.

Although much more could be written on this subject, going to show, even to a greater degree, the effects of dental irritation on the ear, enough has been said, the writer thinks, to call attention to this frequent source of aural affections. The harmful results of retaining dead or diseased teeth in the mouth cannot well be overestimated; and this is especially so in persons by nature more or less prone to catarrhal conditions of the upper air-passages, or whose occupations render them liable to such, from exposure and other sources. The ear, in a state of continual hyperæmia due to this reflex irritation, is much less able to withstand the effects of such outside influences.

Treatment.—When cases of ear-disease, either of the acute or of the chronic variety, come under our observation, it is a wise plan never to neglect a careful examination of the mouth, to ascertain the condition of

¹ Op. cit., p. 98.

the teeth. The pain arising from acute middle-ear inflammation is not infrequently confounded with that caused by decayed teeth, and this often leads a careless observer astray in his diagnosis. When in such a case the existence of a diseased or dead tooth is ascertained, the same should be removed, if its position and relations show a fair probability of a detrimental influence on the aural disturbance. The many recoveries observed to follow the removal of defective teeth in such cases show the wisdom and benefit of this treatment. Care and cleanliness of the mouth should be urged in all cases, and ill-fitting plates removed, or, if replaced by better-constructed ones, patients should be instructed as to the desirability of their frequent removal for the sake of cleansing the mouth of irritating substances. It will be well to advise such persons, moreover, to remove their plates at night, relieving thereby the mucous surface covered by them of the heat and irritation caused by their presence.

It may be urged in all cases that the retention of decayed or dead teeth is detrimental, and especially so in persons whose nervous tone is more or less diminished.

OBJECTIVE NOISES IN THE EAR.

By objective noises in the ear we mean noises and sounds which are not only heard by the patient, but which may also be perceived by another person. Such phenomena have been observed and reported, it appears, by various writers, for a number of years past, although the attention of most otologists has not been greatly attracted to the subject. The latter fact is probably due to the comparative rarity of their occurrence and the little interest aroused by the published accounts of such cases. The subject is one, however, full of interest to both aurist and general practitioner, and offers a field for careful research and study, since these phenomena are due to pathological processes whose nature is rather obscure in most instances.

The noises to be considered here have been likened to the snapping of the finger-nails, or the cracking produced by the sudden separation of the finger-ends when moistened with some sticky fluid. They are heard as such in the ears of some persons, and, as above stated, may be perceived by others. The production of these sounds is, in some instances, dependent on the will of the patient; but in the greater number of cases they appear to be involuntary in their occurrence.

Fabricius ab Aquapendente was able to produce these sounds in both ears at the same time, and Johannes Müller¹ could produce the clicking noise in one or the other ear as he desired, the noise being distinctly audible to others. Müller considered such sounds to be due to contractions of the tensor tympani muscle. H. J. Bigelow² in 1847 reported the history

¹ Manual of Physiology, vol. ii. p. 1262. London, 1838-1842. Translated by W. Baly.

² Boston Medical and Surgical Journal, November 3, 1847.

of a case of objective noise occurring involuntarily in a young woman in whom a sharp clicking sound could be heard across the room, coming to all appearance from her throat. The patient finally recovered.

Schwartz¹, in a paper published in 1864, referred to some experiments of Politzer's going to show that these objective noises heard in the ear at times were caused by a separation of the walls of the Eustachian tube, a view also entertained by Luschka. Schwartz also reported a case at a later date² in which the sound in the ear was synchronous with the movements of the palate, there being at the same time a retraction of the drum-head, especially at the umbo. This latter observation has been also made by others, such as Politzer and von Troeltsch.

Boeck³ published the account of a case in which there was a movement of the thyroid cartilage with each repetition of the sound, and a rhinoscopic examination showed that the anterior and posterior lips of the Eustachian tube were separated every time the palate and thyroid cartilage were elevated. The act of swallowing could reproduce the noise when desired, if it had ceased. Boeck was not inclined to accept the views of Funke,⁴ who endeavored to explain the occurrence of these noises by a sudden stretching between the malleo-incudal articulations. He considered that if this was a correct explanation of the problem, the sounds should also arise on inflation of the drum-cavities with the air-douche, etc. Boeck regarded the views of Politzer and Luschka as the most entitled to consideration. Another case was published by Politzer⁵ in 1868, occurring in a young patient having a perforated drum-head. The slight amount of secretion lodging in this was driven out during the act of yawning, thus proving the associated movement of the tensor tympani muscle. Leudet⁶ recorded a case in 1869, and later on we find two more cases reported by Schwartz.⁷ In the one, the patient, a man forty or fifty years of age, suffered much from a loud cracking noise in both ears. This sound could be heard all over the room, and was entirely involuntary, he being unable to reproduce it during a pause. The noise had been present since his sixteenth year, and was much louder than the normal noise which some persons are able voluntarily to produce. It was not synchronous with the pulse, and was unaccompanied by any movement of the drum-head or thyroid, although the palate showed some movement. The second case was that of a girl, five years of age, who for six months had suffered from snapping noises in both ears, audible to others at a distance of some inches. A slight deafness had

¹ Archiv für Ohrenheilkunde, Bd. i., 1864.

² Ibid., Bd. ii., 1867.

³ Ibid., Bd. ii. S. 203, 1857.

⁴ Lehrbuch d. Physiologie, Bd. ii. S. 113, zweite Auflage.

⁵ Archiv für Ohrenheilkunde, Bd. iv. S. 26; also, Wiener Med. Presse, 1871.

⁶ Gazette Médicale de Paris, 1869, Nos. 32 and 35. Comptes-Rendus de l'Académie de Science de Paris, May 10, 1869.

⁷ Archiv für Ohrenheilkunde, Bd. iv. S. 229.

preceded the advent of these sounds, but this had disappeared at the time the latter appeared. No movement of the drum-head or of the palate was noticeable, and the noise could not be reproduced at will. Küpper¹ reported also a case, due, he considered, to clonic spasm of the muscles of deglutition, in a man aged twenty years. There had been some slight catarrh of the middle ears in this patient, which preceded the development of the peculiar cracking noise in his ears, audible to persons standing close to him. There was also an upward movement of the thyroid, the floor of the mouth, the base of the tongue, and the soft palate, with contraction of the palatal arches and transitory spasms of the muscles of the eyes and nose.

In 1875 a very interesting account of such a case was published by C. H. Burnett.² The objective noises in the ears were accompanied by spasmodic retraction of the membrana tympani and the velum palati. The movements of the drum-head were not observable at first, owing to its thickened condition. Burnett used a small glass manometer, devised by Politzer, its capillary calibre one millimetre in diameter, filled with colored water and placed in the meatus. The latter was also filled with water, the two columns of fluid being hermetically joined by an india-rubber stopper on the manometer. "The column of water," he says, "thus brought into contact with the membrana tympani showed a negative fluctuation of one-half millimetre at each snapping sound, thus demonstrating a retraction of the membrana tympani." Deglutition and rapid respiration increased the frequency of the snapping noises, but when the patient held his breath they ceased entirely. On the patient's throwing his head as far back as possible, also, the noises ceased, although the spasms of the velum palati continued. It is interesting to note that the noises in this case ceased entirely after perforation of the drum-head had taken place, the latter occurring without any explanation whatever. The perforation closed in the course of a week, but the noises did not return, nor did the spasms of the velum palati, Eustachian tube, etc., recur. In the second edition of Burnett's work on the ear, published in 1884, we find, furthermore, two additional cases recorded, both of which were evidently connected with catarrhal disease of the nares and naso-pharynx. In the first, the patient, a young man twenty-eight years of age, had felt the clicking sound in the left ear for twenty months. It was observed that when he said *m*, *n*, or *o* rather loudly, but with no other vowel sound, the clicking in his ear began. Slight motion of the membrane was observed, and the observer was able to hear faintly the clicking sound with the aid of the auscultation-tube. There was no spasm in any part of the pharynx or velum palati. This patient was greatly improved by treatment. The other patient, a young woman twenty years of age, had suffered from a clicking noise in the right ear for six months, which was also noticeable to her

¹ Archiv für Ohrenheilkunde, N. F., Bd. i. S. 296, 1873.

² Philadelphia Medical Times, Nos. 172 and 181, 1875; also, The Ear, etc., Phila., 1884.

family. Its occurrence was paroxysmal, with short intervals, and it was heard objectively as well at the nostrils as at the meatus of the right ear, if not even better. The number of "clicks" was about eighteen or twenty a minute. Pressure upon the muscles over the carotid, and also opening of the mouth to its fullest extent, stopped the noise. There were spasms of the pterygoid muscles on both sides, causing movements of the lower maxilla.

A case of involuntary objective snapping noises in both ears was reported by E. L. Holmes¹ in the Proceedings of the West Chicago Medical Society of March 24, 1879. The patient was a young lady, aged seventeen years, who had suffered since early childhood from involuntary spasms of the pharyngeal muscles. These occurred about forty times a minute, and synchronous with them could be heard distinctly, eighteen inches from the ear, a clicking sound. This could also be heard from the patient's mouth, though not so loud. The lips of the Eustachian tubes could be seen to separate with each muscular contraction. The drum membranes were also observed to move slightly with these spasms. Holmes considered these noises to be due to spasms of the *tensores tympani*.

Bürkner,² Charles A. Todd,³ and R. C. Brandeis⁴ have also each published an account of a case of this phenomenon. In both of these two latter cases the noises were accompanied by synchronous spasms of the soft palate and the uvula, and movements of the drum-heads. Muscular contractions of the sterno-cleido-mastoid, mylo-hyoid, and thyro-hyoid muscles were also present. In a paper on objective noises in the ear, by C. E. Fitz-Gerald, of Dublin, read at the International Medical Congress in London, 1881, that author reported the histories of three cases observed by him. The first case was that of a woman, thirty-two years of age, who had suffered since her seventh year from constant noise in the right ear, in which an attack of purulent otitis had preceded the development of the noise. The clicking sound could be distinctly heard at a distance of fifteen feet from the patient. There was some loss of the hearing-power in this ear, and there was a large perforation in the tympanic membrane. No movement of the malleus or of the remnants of the drum-head was detected, but movements of the *velum palati* synchronous with the clicking sounds in the ear were distinctly seen. The noise ceased, as did also the movements of the palate, on inflation of the *tympanum*, and also on pressure inwards with the fingers behind the angle of the inferior maxilla. The patient had improved much under treatment when last seen by the writer.

The two other cases of Fitz-Gerald's offer good illustrations of another form of objective noises in the ear. In the one a pulsating blowing noise

¹ Chicago Medical Journal and Examiner, May, 1879; also, Archives of Otology, vol. viii. p. 144, July, 1879; also, American Journal of Otology, January, 1880 p. 68.

² Archiv für Ohrenheilkunde, Bd. xv. S. 219, 1879.

³ St. Louis Courier of Medicine, July, 1880.

⁴ Archives of Otology, vol. xii. p. 14, 1883.

in the ear could be distinctly heard by the patient's wife while lying abed, and by the writer by means of a stethoscope placed either over the meatus externus or on the mastoid process just above the auricle. Pressure on the carotid stopped it, and it would not be audible again until the patient assumed a recumbent position. This noise had been present in the patient for about ten days before he came under the observation of the writer. The other patient was a young woman, very chlorotic, who suffered also from a beating noise in the right ear. It had begun about nine or ten months previously, and had ceased after a period of three months, only to return a short time afterwards. When she turned her head to the right the noise ceased, and also on pressure on the carotid. Hearing was normal, as was also the ear to all appearances. The noise could be easily heard by the observer by means of the otoscope. In the former of these two cases treatment resulted in the nearly complete disappearance of the annoying sounds, while in the second instance they disappeared entirely. Poorten¹ makes mention of a case of a woman, forty-five years of age, who suffered from a beating in the left orbit due to an aneurism in the same. There was furthermore a loud blowing noise in the left ear, which could be easily perceived at a distance of eight inches. Cases of this kind have also been reported by H. N. Spencer² and Wagenhäuser,³ in which an objective aneurismal bruit emanated from the ear, being undoubtedly vascular in its origin.

Such murmurs having a systolic origin have been described as objective and subjective murmurs. Two such phenomena were recorded by J. O. Green,⁴ occurring in males, namely, a boy and a man. The extreme sensitiveness of the vaso-motor system was very noticeable in both. Green in explanation of the occurrence of this phenomenon agrees with Richardson, who says they "are produced by a reduced vascular tension, especially of the internal carotid artery, which allows the walls of the artery to lie in direct contact with the osseous walls of the canal in the petrous bone, and thus permits the transmission of the vibrations of the blood directly to the osseous structures in close connection with the ear."

The power of producing *voluntarily* a snapping or clicking noise in the ears has already been mentioned as having been possessed by Fabricius ab Aquapendente and Johannes Müller. Lucae⁵ reported three such cases due in his opinion to contraction of the tensor tympani muscle. Similar cases have been recorded by A. Schrapinger,⁶ Delstanche fils,⁷ S. M. Burnett,⁸

¹ Archives of Otolaryngology, vol. viii.

² American Journal of Otolaryngology, vol. iii., 1881.

³ Archiv für Ohrenheilkunde, Bd. xix. S. 62, 1882.

⁴ Transactions of the American Otological Society, 1878.

⁵ Archiv für Ohrenheilkunde, Bd. iii. S. 201, 1867.

⁶ Transactions of the Austrian Academy of Sciences, vol. lxii., Section 2, October 1870.

⁷ Étude sur le Bourdonnement de l'Oreille, p. 47. Paris et Bruxelles, 1872.

⁸ Archives of Otolaryngology, vol. viii. p. 357, 1879.

Brenner,¹ and other writers. C. H. Burnett² states that he has observed several instances where certain persons affected with an aural disease had this power. In one of them the creaking, whizzing noise took place with visible movements of the cicatrices in the drum-head; in another patient the drum-head was observed to move also, although the noises were not very loud; whilst in a third case the noise occurred in an ear with perfectly normal hearing. Moos³ records a case of contraction of the left tensor tympani muscle synchronous with the act of mastication, which was accompanied by a loud grating noise, distinctly heard near the patient on movement of the lower jaw. The left membrana tympani was seen to move distinctly during this action of the jaw. "This phenomenon," says Moos, "is especially remarkable because the result was confined to one side. If it had been observed on both sides it would have been less remarkable, as the muscles used in chewing and the tensor tympani receive their nerves from the same source."

Sexton⁴ mentions the fact that he has frequently had occasion to observe this power of producing clicking, cracking sounds in the ears of patients, which could be recognized by by-standers. He reports the case of a boy where he could distinctly hear such sounds in the tympanum of the patient by means of a diagnostic tube whenever contraction of the pharyngeal muscles took place.

We find the ages of all these patients reported varying from five to fifty years; and sex seems to have no especial relation to the affection as an etiological factor, since it occurs in both sexes with about equal frequency. A perusal of these reports will demonstrate that noises seldom occurred on more than one side at a time, but in some instances they appeared in both ears. We shall find also that the recurrence of these sounds is sometimes too rapid to be counted, in others they are synchronous with the pulse. They are sometimes so loud as greatly to annoy the patient at night, at other times very faint. In many of the cases cited the hearing was normal; in others defects of audition were present, whilst in other instances it varied with the occurrence of the noises.

Etiology.—In respect to the causes and nature of these objective noises in the ear a number of opinions obtain. The majority of authorities on the subject, however, seem to be more or less agreed that they are due to a spasmodic contraction of the muscles of the velum palati and pharynx, giving rise to "a sudden separation of the anterior from the posterior wall of the pharyngeal portion of the Eustachian tube." Others have taught that the noise was due to contractions of the tensor tympani muscle, or that this was probably the most important factor in such cases. In some of the cases described the mucous membrane lining the pharynx, the inferior

¹ Monatschrift für Ohrenheilkunde, No. 10, 1879.

² The Ear, etc., p. 422. Philadelphia, 1884, second edition.

³ Archives of Ophthalmology and Otology, 1871.

⁴ The Ear and its Diseases, p. 50. New York, 1888.

turbinated bodies, and the nares was in a condition of catarrhal inflammation and hypertrophied, sufficient cause of irritation to the sensitive nerves of these parts to produce reflex spasms of the underlying muscular tissues through the motor nerves. These spasmodic twitchings about the Eustachian tubes would then probably be perceived as subjective and objective sounds. The cessation of these noises on amelioration of the catarrhal conditions would demonstrate that the origin of such sounds lay in the diseased state of the upper pharynx and nares. "The easy excitation of the spasms by talking," says Burnett, "is explained by the fact that a few fibres of origin of the superior constrictor of the pharynx arise from the genio-hyo-glossus, and hence lingual motions would tend to excite the aforesaid sounds in the ear. It may also depend upon the motions of the jaw, as the constrictor has a partial origin from the posterior part of the alveolar process, and upon the movements of the buccinator, which has a common origin with the superior constrictor of the pharynx, in the pterygo-maxillary ligament. The annoying audibility of these muscular spasms is due to the insertion of the superior constrictor near the Eustachian tube."

Numerous instances are observed, however, where contractions of the tensor tympani produce distinctly visible movements of the membrana tympani, without giving rise to any noise, either objective or subjective, and a number of such have been recorded by Sexton.¹ These occurred in subjects suffering from the effects of chronic middle-ear catarrh, the movements of the drum-head being voluntary and usually followed by temporary alterations in the hearing-power. In a case reported by Blau² the chronic spasms of the tensor tympani were not productive of any subjective sensations, although spasmodic motions of the drum-head were easily observable.

The noises thus produced in the naso-pharynx are conveyed to the ear of the patient through the Eustachian tube, and the observer perceives the sound as if it came from the patient's ear. In many of the cases cited, however, it has been noted that the noise could be equally well perceived at the nostrils of the patient. The internal pterygoid muscle arises from the pterygoid fossa, its fibres being attached to the inner surface of the external pterygoid plate and also to the grooved surface of the tuberosity of the palate bone, whilst its internal surface lies in close proximity to the tensor palati muscle; the external pterygoid muscle, on the other hand, arises from the pterygoid ridge on the wing of the sphenoid bone, and also from that part of the bone included between it and the base of the pterygoid process, from the outer surface of the external pterygoid plate, and, furthermore, from the tuberosity of the palate and superior maxillary bones. Vibrations, therefore, taking place in the muscular structures near their points of attachment would be easily communicated to the drum-cavity by the Eustachian tube, and also to the external air by the nares.

¹ Op. cit.

² Archiv für Ohrenheilkunde, Bd. xiii. S. 261.

Wreden ascribed this peculiar snapping noise in one case to a clonic spasm in the stapedius muscle. This case is unique, if we except perhaps the case described by C. H. Burnett,¹ where, however, the author was more or less in doubt as to the actual nature of the affection, since nothing but the faintness of the noise led him to conclude that the spasm was one of this muscle.

It is most probable, the present writer believes, that these objective noises are produced by contractions of the palatal muscles simultaneous with contractions of the tensor tympani. As is well known, the tensor and levator palati muscles are intimately associated with the tensor tympani muscle in the performance of the aeration of the tympanum. The fibres of these muscles are often intimately blended, and their aponeurotic connection along the Eustachian tube always exists. This would suggest that they are probably not independent of each other in their actions. According to Sexton,² "during expiration, deglutition, etc., when the palate is elevated by the tensor palati, the membrana tympani is retracted towards the inner wall of the tympanum by the tensor tympani. The effect of contractions of the tensor tympani would be, therefore, to assist in elevating and opening the Eustachian tube for the admission of air, at the same time preventing the current from forcing the membrana tympani unduly outwards and thus interfering with the equilibrium of auditory tension." It seems apparent, therefore, that the constrictor muscles of the pharynx control, with the help of the palatal muscles, the air-renewal in the drums of the ear. The action of these muscles would, moreover, produce an opening of the Eustachian tube orifice, by the separation of its walls from each other.

Treatment.—The means at our command for treating successfully such cases are not numerous, so far as experience has shown. The induced current was highly recommended by Boeck, and also by Politzer, as having greatly improved the audition of the patients in their cases. Schwartz states, however, that in his own experience he has met with no permanent results from its use. Burnett tried the same measure in one of his cases, without any benefit, however. Treatment with arsenic, cod-liver oil, quinine, iron, and other tonics has also apparently failed to give any beneficial effects. In Fitz-Gerald's two cases of pulsating noise, above cited, the author prescribed fifteen minims of hydrobromic acid to be taken three times daily, in one instance in conjunction with sulphate of iron pills (Blaud). The results, he states, were markedly beneficial. Burnett advocates a treatment directed to the nares and naso-pharynx generally as having produced the best results in his own cases. This would, indeed, seem most reasonable, especially in cases where a catarrhal condition of this region exists, relief of which should be followed by amelioration of the conditions caused by the irritated state of the mucous membrane.

¹ The Ear, p. 424. Philadelphia, 1884, second edition.

² The Ear and its Diseases, chapter iii. p. 43. New York, 1888.

CHRONIC PURULENT OTITIS MEDIA.

BY CHARLES H. BURNETT, A.M., M.D.,

Emeritus Professor of Otology in the Philadelphia Polyclinic; Clinical Professor of Otology in the Woman's Medical College of Pennsylvania; Aural Surgeon to the Presbyterian Hospital, etc., Philadelphia, Pa.

PART I.

GENERAL CONSIDERATIONS; CAUSES AND SYMPTOMS.

CHRONIC purulent otitis media, as its name indicates, is a chronic purulent inflammation of the middle ear. The parts involved primarily and most frequently are the Eustachian tube and the tympanic cavity, with the membrana tympani. Later in the disease the attic space, the upper part of the drum-cavity beneath the tegmen tympani, may be affected, and, finally, the mastoid aditus, antrum, and pneumatic cells may be involved in the purulent process in the order named.

There is a group of cases in which the chronic purulency is limited at first to the attic space, with, perhaps, some involvement of the aditus and antrum, the atrium, or lower part of the drum-cavity, being free from purulency and showing a tendency to remain free. These cases are not numerous, but they form a most important class, as they are invariably attended with necrosis in the head and neck of the malleus and the incus. They lead to disease in the mastoid antrum, with risk of further mastoid disease, if not relieved before the necrosis advances backward towards the mastoid, or attacks the neighboring walls of the antro-tympanic space.¹

Every endeavor should be made to check a chronic purulent discharge from the ear. There should be no fear to do this as promptly as possible, for so long as a chronic purulent discharge comes from an ear, the patient's life and hearing are in danger. No credence should be given to the old sayings that the ear "should not be dried up" for fear of "driving it to the brain," etc., as they are mere subterfuges of ignorance and inability to treat the disease successfully. Unhesitatingly it can be said that unless the purulency is checked the disease tends to attack the brain. Therefore, chronic purulent discharge from the ear demands earnest consideration,

¹ Recessus epitympanicus.

prompt and scientific treatment, and a thorough cure, if it can be obtained. So grave is this disease that some insurance companies will not take the risk on the life of an applicant thus diseased.

The hearing is often greatly impaired or entirely destroyed before any treatment has been applied to the ear. At last the offensiveness of the chronic discharge from the ear and the attacks of pain and dizziness lead the patient to seek surgical aid. The patient should now be encouraged to proceed with treatment, not purely with the hope of recovering hearing, but to prevent the advance of the disease from the middle ear to the mastoid region, the lateral sinus, and the brain. In fact, the patient should be judiciously informed of the risks of allowing a chronic purulent otitis media to take its own course, and that fatal brain-disease or pyæmia, or both, are but the logical sequence of a continuance of the corroding disease in his ear.

ETIOLOGY.

Any cause productive of an acute purulent otitis media is competent to produce chronic purulent otitis media. The most common causes assigned are coryza and the exanthemata, especially measles and scarlet fever, the latter being the most frequently assigned cause. Teething, diphtheria, and typhoid fever are sometimes assigned as causes of chronic otorrhœa, and within the last two years la grippe has left behind it some cases of chronic purulency in the ear or ears. I have observed that phthisical subjects show a predisposition to a form of acute purulent inflammation in the middle ear, which is not painful and which falls quickly into a chronic condition, in many cases bidding defiance to treatment. Chronic otorrhœa persists like suppuration in serous membranes, because the chronic purulency originates in a cavity lined with a membrane subject to pathological processes comparable to those in serous membranes.

It is found in scrofulous, lymphatic, arthritic, herpetic, tuberculous, and syphilitic diseases, and is generally associated with naso-pharyngeal catarrh. Hence its treatment must consist in local treatment of the ear and naso-pharynx as well as in constitutional measures.

As the exanthemata are fruitful causes of chronic purulency in the middle ear, this disease begins in childhood, and for various reasons is *allowed* to become chronic. I say *allowed*, because whenever an acute purulent otitis media is properly treated it never becomes chronic, so far as my experience has gone. Too often the indifference or ignorance of the parents and their doctors, added to the desire of the child to shirk regular care and treatment of the diseased ear, has led to neglect of the case from its inception. Septic matter, therefore, has been permitted to lie in the ear, purulency has advanced farther into the organ, the hearing has grown worse, and finally, in the course of a year or two, the child has become offensive to his family, a burden to his teachers or employers, and a great mortification to himself, on account of his deafness and the ill-smelling discharge from his ear. This condition of the child is especially deplorable, because, according to the

writer's experience, no case of acute purulent inflammation will become chronic, *no matter what its cause*, if properly treated at the outset.

Diphtheria as a Cause.—Diphtheria is very often followed by a virulent form of chronic purulent inflammation of the middle ear in children. There seems to be a tendency in this disease for the purulent otitis media to fall at once into a chronic form. Pain is not always present, and the acute process is not well marked. Granulations spring up in a few days, the bone becomes necrotic, and sequestra are thrown off from various parts of the temporal bone.

It is therefore advisable, in order to prevent destruction of the middle ear, to examine the organ in every case of diphtheria, especially if the patient's attention is called to his ear by discomfort in it; and if the membrana tympani bulge with matter behind it, it is best to make a free incision into it at once. This would favor the escape of pus from the drum-cavity and prevent burrowing to deeper parts.

One sex is as liable as the other to chronic purulent otitis media. Women are more sensitive about chronic and offensive discharges from their ears than men. This may account for their anxiety to be freed from such annoyances and their greater willingness to undergo treatment to attain this end. Hence girls and women are found to preponderate in our lists of patients. Boys and men, being less sensitive about such personal matters, are not so likely to present themselves for treatment, but, being more exposed to the elements, are, perhaps, really more frequently affected than girls and women.

Chronic purulent otitis media in *drunkards*¹ is rapidly developed, the nerve-centres are simultaneously invaded, and the extent of the disorder is great under the influence of alcohol. The latter has a deplorable influence upon the course of chronic purulent otitis, as upon that of all other diseases.

SYMPTOMS.

The chief symptoms of uncomplicated chronic purulent otitis media are either hardness of hearing or profound deafness and a purulent discharge from the ear. There may also be tinnitus aurium, more or less constant, and occasional attacks of vertigo. In the debilitated and squalid there may be frequent attacks of earache and so-called "gatherings in the ear." The vibrating tuning-fork placed on the vertex may be heard quite well in the diseased ear if the labyrinth has not been invaded by the inflammation. Should the patient fail to hear the tuning-fork, by bone-conduction, in the diseased ear, it would indicate that probably the chronic purulency had invaded the inner ear, and that the case all the more demanded prompt treatment to prevent still deeper advance of the disease.

The Discharge.—The discharge is usually more copious in children than in adults. In the latter, the discharge is more likely to be copious the less chronic the disease,—a feature due, in all probability, to the more active con-

¹ Noquet, *Revue de Laryngologie*, Nos. 1 and 2, 1889.

dition of the inflamed mucous membrane in the middle ear. As the disease advances, the mucous membrane is either destroyed or so greatly altered in structure as to cease to throw off much secretion, and the discharge in such cases becomes thinner, more offensive, irritating, and suggestive of necrosed bone. In children the discharge is copious, because of the usually attendant activity of the mucous membrane of the nares, naso-pharynx, Eustachian tube, and middle ear. Hence in young patients the purulent discharge is mixed with strings of mucus, more or less transparent, from the Eustachian tube and tympanic cavity. The color of the discharge varies from a light yellow to a dark yellow or green, but there is no rule about this feature. It will be observed that the more copious discharges from the ears of young children are lighter in color than the scanty, which are usually quite dark. The slighter discharges of adults afflicted with chronic purulency in the middle ear are dark and more likely to form crusts or scabs in the meatus.

In most cases there seems to be a peculiar butyric odor to the discharges of chronic suppuration from the ear. This is largely due to a want of cleanliness. There will be very little odor in an ear thus diseased if it is kept clean and no necrotic bone is retained.

Minute perforations in the membrana are attended by slight and intermittent discharge. The chronic purulent inflammation in such cases is limited to the inner surface of the membrana tympani, near the perforation.

Appearances of the External Auditory Canal.—Inspection of the ear by means of the ear-mirror and the ear-funnel or speculum will reveal mucopus in and about the meatus and lying in the canal, more or less maceration of the skin of the auditory canal, and perforation or entire destruction of the membrana tympani, with inflammation of the mucous membrane beyond it in the drum-cavity. In order to obtain a good view of the external auditory canal and drum-head, the canal must be syringed, and then it and the fundus of the canal and membrana gently mopped dry by means of a tuft of absorbent cotton on a cotton-holder. Syringing alone or mopping alone is rarely able to cleanse the ear sufficiently to allow of a good view of the diseased parts. Inspection of the diseased ear will now reveal maceration of the cutaneous lining of the canal, and in very chronic cases one or more small exostoses, generally in the fundus of the passage near the annulus tympanicus. If the chronic discharge is not copious, the maceration of the skin in the auditory canal is not great. Instead of that, there are formed scales and crusts of hardened pus, mucus, and epidermis in the inner part of the auditory canal and on the outer surface of the upper part of the drum-membrane in the region of the membrana flaccida. In cases of copious discharge, the delicate skin lining the inner part of the bony auditory canal becomes more like mucous membrane than like skin, as it is denuded of epithelium and secretes a thin pus. This has led to the erroneous idea that the inner part of the auditory canal is normally lined with mucous membrane. This condition of the skin in the auditory canal is oftenest seen in those who have resorted to swabs of various sorts for cleaning their

ears. This manipulation has led to abrasion and denudation of the skin in the fundus of the canal, with formation of ulceration, granulations, and polypi in some instances.

Increased Temperature.—It is asserted by Ryerson, of Montreal, that in the course of treatment of chronic suppuration of the middle ear there are times when the auricle feels warmer than usual to the hand. This increase of warmth of the ear often corresponds with an increase of discomfort in the ear or even with pain. Dr. Ryerson, upon inserting a thermometer into the external auditory canal, found that in such cases there was on the affected side an increase of temperature of from one-eighth to one degree. At such times hot douching of the ear is indicated and will generally give relief.

PART II.

CHRONIC SUPPURATION OF THE ATRIUM.

In considering chronic purulent otitis media we shall be obliged to bear in mind the effects of chronicity rather than the duration of the disease, and also its chief, perhaps solitary, seat. Let us take up first purulency of the atrium and perforation in the membrana tensa. In a child five or ten years of age there may be found far more serious lesions from the chronic purulency than those from a process of greater duration in an adult. Logically, all cases tend towards the same end, but in many the pace towards serious consequences is much more rapid.

Hence in a child four or five years of age, in whom the chronic purulency has existed for a year or two, or even less time, there may be found a large perforation in the membrana, a copious and offensive discharge, polypoid granulations, and a carious spot on the inner wall of the tympanum. Again, in a child of fifteen, in whom the purulency has continued for ten or twelve years, there may be found a small perforation, with a solitary polypus, with the history of the removal of similar ones, scanty discharge, and necrosis of the lower end of the malleus. The mucous membrane of the drum-cavity in such a case may be found swollen, with a tendency to bleed if touched, the hearing greatly reduced, and there may be evidences of former mastoid disease and abscess behind the auricle.

In adults, surprising resistance to the chronic purulency is shown in many cases; but of course it is in them that the worst lesions, the most direful results, both of neglect and of improper treatment, are to be found. The ravages of the latter, in some instances, are so much greater than those of the disease, that it would have been better if the disease had been left to nature. We are wont to hear a good deal about the evils of neglect of this disease, but the tide of no treatment has been succeeded by such a flood-tide of treatment, not always the wisest, that many cases have suffered as much from bad treatment as they could have from neglect.

Even in quite young subjects the results of bad treatment are seen to be

worse than the ravages of the disease would have been if it had been let alone. The case of a young girl sixteen years old is recalled. While teething, an otorrhoea set in. She was taken at once to a physician, who began treatment and continued it for thirteen years, with varying conditions in the ear. The treatment consisted chiefly in swabbing the fundus of the ear with a solution of nitrate of silver of a strength unknown to the patient's family. Finally, the case was sent for inspection to the author, who found that every vestige of the membrana tympani, membrana flaccida, and ossicles had disappeared. The inner wall of the tympanic cavity was fully exposed to view, the oval window could be plainly seen and touched, and the niche for the round window was also plainly visible. Dizziness could be quickly induced by touching the oval window, but whether this was closed by the foot-plate of the stapes or by a fibrous membrane could not be determined. The destruction had invaded the region of the segment of Rivinus so deeply as to expose the attic region completely. A ridge running in the course of the facial canal was supposed to be the latter. There were spots on the inner wall of the tympanic cavity denuded of muco-periosteum, and there were also one or two small granulations not disposed to bleed much when touched. The whole field of disease in the fundus of the ear was a dirty white, with a little secretion of pus. The hearing was entirely destroyed.

Again, in a man, forty years old, neglect coupled with bad treatment—viz., cauterization now and then, and the constant wearing of cotton packed into the fundus as deeply as possible—had induced a similar state of affairs and a very similar appearance in the drum-cavity. There was, of course, profound deafness; but in addition to this symptom there were frequent attacks of a peculiar lethargic feeling, with more or less vertigo, often after fatigue, and great depression of spirits supervening. Discontinuance of the constant presence of a cotton pellet in the drum-cavity, and a mild antiseptic treatment, relieved the symptoms entirely.

In another adult, a man forty years old, an opportunity was offered of studying the natural history of neglect of chronic purulent otitis media of traumatic origin. The patient stated that in early boyhood his teacher boxed his ear upon one occasion. He was soon seized with pain in the ear, which, however, was quickly relieved by spontaneous discharge of matter. The discharge continued, however, with varying quantity, for years, nothing being done for it beyond an occasional syringing. An aurist was once consulted when the patient was about thirty years old. The ear was syringed violently by the aurist, and violent vertigo was induced at once. The patient—a clergyman—did not return to this operator. Several years later, when I saw him, the posterior and upper walls of the auditory canal were destroyed sufficiently to throw the canal, the mastoid cavity, devoid of pneumatic cells, and the tympanic cavity, including the attic, into one large cavity. There was not a trace of membrana tympani or ossicula. The tympanic and mastoid cavities were lined with a very red, smooth, slightly purulent mucous membrane. There was no denuded bone, no odor, no history of

any severe attack of pain in all the years of the duration of the disease. The patient had syringed, and still continues to syringe, the suppurating cavity daily with warm water, which keeps the ear aseptic, and seems to control the discharge.

APPEARANCES OF THE DRUM-HEAD AND THE TYMPANIC CAVITY.

Chronic purulent discharge from the tympanic cavity presupposes a perforation in the membrana tympani. Such a perforation may be at any point in the membrana, least frequently, however, in the flaccid part, the so-called Shrapnell's membrane. Let us first consider disease of the atrium or lowest part of the drum-cavity, with perforation of the membrana tensa, the part below the folds of the drum-head. Generally in such cases the attic is little involved and the membrana flaccida imperforate. A perforation in the membrana tympani may vary from the size of a pin-hole to that which embraces the entire drum-head. Usually, even in the worst cases, a rim about the annulus tympanicus is left, from which, if the purulency is stopped, a new membrana may grow. The usual seat of a perforation is in the posterior half of the membrane. Multiple perforations are rare; sometimes, however, two may be found close together in the under part of the membrane, separated by a thin band, and in very rare cases three perforations may be found in the same membrane. The handle of the malleus may remain intact, notwithstanding great destruction in the drum-head. In other instances the manubrium may be more or less eroded as the perforation extends. If the membrana is destroyed, or if the perforation in it is in the upper and hinder part, the lower portion of the long process of the incus, the incudo-stapedial joint, and the rami of the stapes, as well as the niche for the round window, may come into view after the ear is cleansed from pus and then dried out with cotton on a cotton-holder. (Fig. 1.)

Nevertheless, a large perforation may exist in the upper and hinder parts of the membrana tympani, and the ossicles be intact, yet invisible, for they are a little higher in the tympanic attic (antro-tympanic space) in some individuals than in others. In some cases the mucous membrane about them is too swollen to permit of their ready recognition. When a large perforation is in the upper posterior quadrant, the lower ends of these ossicula may be seen by inclining the patient's head towards the opposite shoulder, and then looking up and behind the rim of membrana still intervening between them and the observer. This view will be favored by the observer's slowly moving his head and eye so as to command all parts in the region of the roof of the tympanum.

FIG. 1.



Cotton-holder.

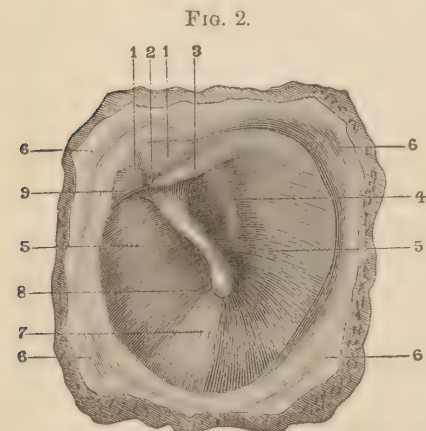
The appearance of the membrana tympani, or its remnant, will vary from one of great opacity and grayness, with red and cicatrized edges of the perforation, to one of uniform redness and thickness. The membrana in the latter condition may be denuded of its outer skin-layer, studded with some granulations, and secrete pus. The manubrium, or handle of the malleus, may be buried in the thick and swollen membrane; or, if the latter is gray and thick, the position of the manubrium is often marked by only a tracery of congested vessels. In other cases, the handle of the hammer is seen as a ridge in the membrane of the same color, be that either gray or red. Sometimes the handle of the malleus projects alone into the perforation and gives a heart-shape to the perforation. When the perforation is large, the membrana tympani is retracted, because the antagonism of the membrana to the tensor tympani muscle is removed by this loss of substance. Where the membrana tympani is perforated, inflation of the drum-cavity produces a "perforation whistle," caused by the air escaping into the external ear.

TREATMENT OF CHRONIC PURULENT OTITIS MEDIA.

The treatment of chronic suppuration of the middle ear must be modified by the stage of the disease and the conditions which it has brought

about in the ear. The duration and cause of the disease should be found out, if possible, the post-auditory region examined for signs of active or healed mastoid sinuses, and inquiry made whether facial paralysis has ever been noted in the case under examination. The condition, too, of the nares, nasopharynx, and fauces should be ascertained, and if these parts are diseased they must be subjected to treatment.

Our consideration shall be given first to the treatment of an uncomplicated case of chronic purulent otorrhœa in which the atrium is principally involved and the sole perforation is in the membrana tensa (Fig. 2, ⁵, ⁵). In order to make a diagnosis and effect improvement or a cure in such a case,



OUTER SURFACE OF A NORMAL MEMBRANA TYMPANI, left side, magnified $3\frac{1}{2}$ diameters (Politzer).—1, 1, membrana flaccida; 2, short process of the malleus; 3, posterior fold of the membrana tympani; 4, incus-stapes joint showing through the membrana; 5, 5, membrana tensa, behind which lies the atrium; 6, 6, 6, 6, inner end of bony auditory canal, forming frame for the membrana tympani; 7, pyramid of light; 8, umbo, containing the lower end of the manubrium mallei; 9, anterior fold of the membrana tympani.

the first endeavor must be to cleanse the ear and to keep it cleansed by means of antiseptics. Antisepsis and asepsis must be maintained if a rational course of treatment is to be pursued.

Antisepsis can be best obtained by syringing the ear or by mopping it with absorbent cotton. Cleansing the ear, as about to be described, should be done only by the surgeon. For syringing the ear, a solution of common table-salt in warm water (five per cent.), a solution of carbolic acid (two and a half per cent.), a solution of bichloride of mercury (one to three thousand or one to four thousand), and a weak solution of permanganate of potassium are among the simplest and best. If the secretion is very thick and tenacious, a solution of peroxide of hydrogen may be instilled slowly into the ear. This valuable drug cannot be heated without decomposing it, and therefore has to be used at the temperature of the surrounding atmosphere. It thus constitutes an exception to the rule to use warm solutions for instillation or syringing into the ear. This solution breaks up thick pus, and then the ear may be further syringed and thoroughly cleansed.

It should not be necessary to say that the injected fluid must be kept separate from the return fluid which comes from the ear loaded with the products of suppuration. This can be done by using a vessel with a partition across the diameter, or by having two basins, one full of the fluid to be injected and the other empty for receiving the washings from the ear.

If the quantity of discharge is both slight and thin, it can be mopped out of the external auditory canal and its fundus by absorbent cotton on a cotton-holder, under thorough illumination of the ear by the forehead mirror (Fig. 3) or the forehead electric lamp (Fig. 9).

While this method will grossly cleanse the ear, so that a view of the fundus of the canal and the membrana tympani may be obtained, it will not chemically cleanse it and render it aseptic, like syringing. Therefore, if a more thorough antisepsis is to be sought by means of the mop on the holder, the cotton mop must be soaked with some antiseptic, and the fundus of the canal and the tympanic cavity, as far as possible, gently but thoroughly mopped and washed with the excess of the antiseptic fluid which will be then squeezed out into the diseased region, under good illumination, as just stated. There must be no perfunctory mopping and grubbing in the ear in any case, nor any guess-work about these manipulations. Therefore they can be done only by the skilful and conscientious surgeon.

Sometimes adult patients may be allowed to syringe their ears by means of a soft-rubber ball syringe (Davidson's, No. 6, or Davol's No. 51), which never gets out of order and cannot be broken easily. A patient should never use a piston-syringe, as he is likely to do himself more harm than good with it. Mopping the ear by the patient, by curling up cotton and running it into the canal and twisting it down to the fundus, sooner or later excoriates or irritates the canal. This manipulation

FIG. 3.



Forehead reflecting mirror.

also rubs septic matter into the hair and other follicles of the skin of the canal, and leads to furunculosis. Hence, as far as possible, cleansing the suppurating ear, like other important surgical measures, should be left to the surgeon.

After the ear is cleansed it should be thoroughly and most carefully examined first for granulations and polypi. If such complications are detected, they must receive treatment as hereinafter described.

If these obstructions to treatment and vision do not exist, a slender but blunt probe should be passed carefully down the canal, and the walls of the osseous canal, the malleus or its remnant, and the inner wall of the tympanic cavity should be cautiously examined for denuded, carious, or necrotic spots. It is very important to know whether the latter conditions exist in the ear about to be treated, as their presence contra-indicates all forms of caustic treatment, especially in caries of the inner tympanic wall. The facial canal, which at best is separated from the tympanic cavity only by a thin osseous wall, and which often, even in a healthy ear, has a dehiscence in it from defective ossification, is easily penetrated by any fluid put into the drum-cavity, and the facial nerve directly attacked. If caries of the inner wall of the drum-cavity exists, the thin facial canal-wall is almost surely open and the facial nerve exposed. It is not uncommon to see an acute attack of otitis media from a cold in the chronically diseased ear followed by facial palsy, simply from pressure upon the nerve by the swollen mucous membrane of the drum-cavity. What may not follow the application of a caustic to the carious tympanic wall if the facial canal is open? In fact, facial paralysis has thus been caused. The treatment of caries of the canal, the malleus, and other ossicula of the tympanic cavity and adjacent parts will be considered farther on. Whether caries and necrosis exist or not, in chronic suppuration of the middle ear caustics will never render the aid obtainable from mild antiseptics.

Asepsis having been obtained as stated above, an endeavor must be made to maintain it. The ear should be cleansed every day or two, according to the nature and quantity of secretion and the rapidity of its formation. Some cases secrete a thin muco-purulent matter, while others tend to the formation of thick pus. Any discharging ear is offensive in odor if it is not kept clean, and even those which are the most offensive when first seen soon emit very much less odor when they have been kept clean for a few days. After syringing with a simple antiseptic wash, the ear may be mopped out with some of the solutions named on p. 417, or with a solution of yellow or blue pyoktanin, or with a solution of mercuric bichloride, as follows:

R Hydrarg. bichlorid., gr. $\frac{1}{4}$;
 Acid. tartaric., gr. x;
 Aquæ destill., f $\frac{3}{4}$ iii,¹

or with spirit of wine. Some authorities convey antiseptic solutions directly

¹ Dr. R. T. Randolph, New York Medical Record, July 27, 1889.

to the drum-cavity, through the perforation in the drum-head, by means of the tympanic syringe (Fig. 13).

After the ear has been cleansed it may be rendered more continuously aseptic by the insufflation of finely-powdered borax, boric acid calendulated,¹ boric acid and iodoform (seven parts of the former to one part of the latter), resorcin, aristol, iodoform (a small quantity), or boric acid hydrastinated in the same manner as boric acid is treated by tincture of calendula.

These are soluble, simple, and efficient, but must be blown in in small quantities, just enough to dust over the fundus, and never packed in or held in by a tampon. Asepsis and the checking of the discharge must be the aurist's aim, not the retention of matter. Therefore no application should prevent the escape of pus from the ear, as all forms of sticky ointments, oils, or tampons will surely do. Powders may be insufflated into the ear by means of hand powder-blowers, or by a blow-pipe made of a foot of soft-rubber tubing and a quill or glass end-piece for taking up the powder and conveying it into the ear-funnel,—of course under perfect illumination. (Fig. 4.) A better aim at the diseased parts can thus be taken, and a gentle

FIG. 4.



Method of insufflating powders into the ear.

puff from the surgeon's mouth will carry the powder directly to the fundus, to the attic or the atrium, or to any spot on the walls of the auditory canal. Some authorities convey fine powders, like the above-named, directly to the drum-cavity by means of a powder-blower with a very long and fine nozzle resembling that of the tympanic syringe. Where the perforation is large (from three to eight millimetres in diameter), this is not necessary, and where it is smaller a better way to insure medication of the drum-cavity

¹ Take equal parts of boric acid and tincture of calendula, minin for grain. and let them dry over a water-bath. Then retriturate the dry powder and mix with pure boric acid, one part of the former to two parts of the latter. (S. Sexton.)

is to instil an antiseptic fluid into the ear and cause the patient to inflate his ear by Valsalva's method, or for the surgeon to inflate the ear by Politzer's method or the Politzer-Holt method, the latter a most valuable modification in just such cases.

Advantages of Antiseptic Powders.—Some time ago a comparison of a series of cases treated by the fluid method (by instillation of drops of various medicaments) with a series of consecutive cases treated by the dry method (by insufflation of antiseptic powders) showed that it required two hundred and twelve days by the "fluid method" to effect a cure or improvement of the otorrhœa, while by the "dry method" it required but thirty-five days to accomplish the same object.¹ The latter average was greatly increased, furthermore, by one hundred and eighty days devoted to the treatment of severe otorrhœa in two mutes.

This treatment by antiseptic powders or instillations should be carried out daily for a few days, and then every second day, or at longer intervals, as the discharge begins to decrease. If this treatment by antiseptics and asepsis does not benefit the patient within a month or two, if the mucous membrane of the drum-cavity is granulating or swollen and drainage from it defective, and if the malleus or any portion of the tympanic wall is carious, the membrana tympani, the malleus, and the incus should be excised.

GRANULATIONS AND POLYPI.

Granulations.—A purulent inflammation of the middle ear may lead rapidly to the formation of granulations (small polypoid growths) about the edges of the perforation and on the mucous membrane of the drum-cavity. These results are most likely to occur as a consequence of neglected and chronic suppuration of the tympanum. Granulations are rarely attached to the skin of the auditory canal unless the skin has been ulcerated or wounded during the purulent process in the tympanic cavity. All granulations should be considered incipient polypi. True polypi are insensible to the touch.

Polypoid hypertrophy of the mucous membrane of the middle ear, with hernial protrusions through the perforation, occurs not uncommonly in chronic suppuration of the drum-cavity. These protrusions resemble polypi in appearance, but, unlike them, are very sensitive to the touch. The mucous membrane of the tympanic cavity is in any case predisposed to hyperplastic processes and to the formation of rugous elevations and firm projections. By continued growth and constant enlargement these formations may entirely fill up the tympanum, and, after perforation of the membrana tympani, fill the entire auditory canal. They may also cause flat, bridge-like adhesions to form between the membrana tympani, the auditory ossicles, and the walls of the tympanic cavity. Cystic cavities may be formed by the union of several elevations with one another.

¹ Treatise on the Ear, C. H. Burnett, pp. 472, 473.

Aural Polypi.—Aural polypi vary in size from one millimetre to three or four centimetres in length. The latter, after blocking the entire auditory canal, extend beyond the meatus into the concha. Their surface is usually papillated, looking like a mulberry, particularly near their base. Their consistence is soft but elastic, and their color may be any shade of grayish-pink or red. Aural polypi are often multiple, several being found in the same ear. In very rare instances one of the auditory ossicles may be embedded within the substance of the polyp. A polyp, by its pressure, may markedly enlarge the osseous part of the external auditory canal. Polypi may originate from the mucous membrane or muco-periosteal lining of any portion of the tympanic cavity. In some instances they may spring from the dermoid layer of the membrana tympani or from the skin of the external auditory canal. Their most frequent point of origin is from the upper and inner walls of the drum-cavity.

Polypi are most frequently found in males, and before thirty years of age. The vast majority occur in cases of suppurative disease of the middle ear, and when they are situated on the wall of the external auditory canal it will be found that the suppurative process has been a prolonged one. In fact, all these growths may be considered inflammation-tumors, distinctly illustrating the doctrine of the inflammatory origin of all neoplasms.

Aural polypi should be classified as follows: 1. *Granulation-tumors*. 2. *Soft papillomata*. 3. *Fibromata*. 4. *Myxomata*.¹

1. *Granulation-tumors* are usually of small size, very dark in color, of soft consistence, and bleed easily and freely when touched. They comprise about one-half the entire number of aural polypi, and are usually found in cases where the suppurative process has been rapid and intense. Their structure is that of a simple granulation, from which they markedly differ, however, in being covered by a layer of either columnar or squamous epithelium cells, the latter of which may form a dense horny coating to the growth. (Fig. 5.)

2. *Soft or mucous papillomata* occur as large, club-shaped tumors, of light color, elastic, and not readily bleeding under the touch. They are usually found in cases where the irritation has been very prolonged, but

FIG. 5.

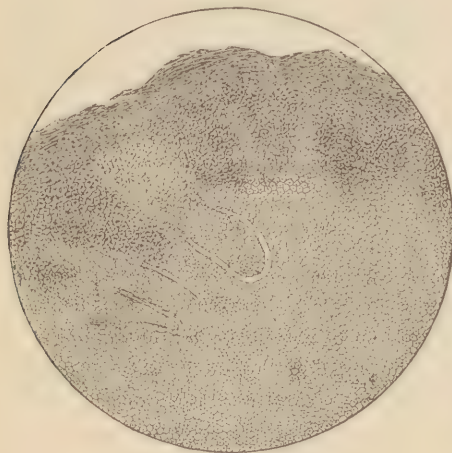


¹ Drs. R. W. Seiss and Walter Chrystie, Burnett's Treatise on the Ear, 2d ed., p. 497, 1884.

not of a high grade of intensity. They comprise about ninety per cent. of all aural polypi other than granulation-tumors. Their surface is generally much lobulated, giving frequently a mulberry-like appearance to the growth. (Fig. 6.)

Their stroma is composed of dense, somewhat imperfectly developed connective tissue, which sends out numerous papillary projections, each containing a capillary loop. Each projection is covered by a layer of cuboidal epithelium, which is so great in amount as to fill up the sulci between the pillars. Many of the pillars send out secondary branching papillæ. Near the surface of the growth the epithelium becomes squamous; in some examples of this neoplasm this covering is hard and bony in character. Spots of myxomatous degeneration frequently occur in these polypi, especially when they have persisted for a long time.

FIG. 6.



Very vascular or even cavernous examples of this class are occasionally met.

3. *Fibromata*, in the true meaning of the word, are extremely rare, the so-called "fibrous tumors" of clinical otology being in the majority of cases examples of soft papillomata. They are developed from the periosteal lining of the tympanic cavity,¹ and are large, dense, pale-colored polypi, usually covered by a multiple layer of pavement epithelium.

4. *Myxomata* occurring in the ear are even rarer than polypoid fibromata, not half a dozen instances having yet been satisfactorily described.

Any of the four classes of aural polypi just described may present examples of cystic, cheesy, and telangiectatic changes having taken place within the structure of the neoplasm. Extensive fatty degeneration may also be present, which may spontaneously amputate the growth by destruction of its pedicle. Osseous and cholesteatomatous masses have also been described as occurring in the substance of aural polypi. Epithelioma, osteo-sarcoma, and gummata have been said to arise from the middle ear, but they are in any event exceedingly rare and imperfectly described. All aural tumors belonging to the four classes of the schedule given above—possibly with the exception of fibromata—are entirely benign, showing no propensity whatever to involve surrounding normal tissue, nor tendency towards recurrence after thorough removal and proper after-treatment.

¹ Schwartze, Pathological Anatomy of the Ear, p. 126.

Fibroids may at times exhibit the rapid growth and semi-malignant character of some of those found in the nasal fossæ.

Among *unusual* formations or growths in the suppurating ear may be named "cysts," "organized blood-clots," "venous blood-sacs," "papillæ on the dermoid layer of the membrana" (J. O. Green), and "organized vesicular polypi" (Burnett). In one of the latter the author found the necrosed long process of the incus. It was removed from the ear of a boy seven years old, who had suffered some time with chronic purulent otitis media.¹

It cannot be said that there is any special train of symptoms indicative of the presence of an ordinary aural polypus. Wherever a chronic purulent discharge from the ear has existed for some time, the presence of a polypus may be suspected, especially if from time to time there has been any hemorrhage from the ear. Usually, however, the only symptom is the chronic discharge from the ear.

Reflex Phenomena.—In some rare instances aural polypi may produce hemiplegia, as shown by Schwartze.² In this case there were anæsthesia and ptosis without facial paralysis on the corresponding side. Removal of the polypi caused the symptoms to vanish. Other reflex phenomena from the peripheral irritation arising from a polypus in the ear have been observed, such as epileptiform convulsions, severe occipital pain and pain in the ear, unsteadiness of gait, elevation of temperature, complete paralysis of the facial nerve,³ a constant tendency to faintness, and great muscular weakness, all of which have disappeared upon the removal of the polypus from the ear.

Hemicrania, sensations of fulness in the ear, vertigo, retention of pus, nausea, and vomiting have often been observed as the result of the presence of a large obstructive polypus in the auditory canal; but they are not to be regarded as characteristic of the presence of polypi generally. The vast majority of aural polypi are first discovered by the surgeon when the patient applies for relief from a chronic aural discharge, the latter being the only symptom.

TREATMENT OF GRANULATIONS AND POLYPI.

Granulations (p. 420) usually disappear under careful antiseptics of the ear, especially when it is maintained by powders (p. 419) or by instillation of alcohol. If this simple form of treatment does not check the discharge and cause the granulations to disappear, the latter may be most carefully touched with chromic acid. This should be done by dipping a probe, with an end not more than one millimetre in diameter, into a drop of deliquesced chromic-acid crystals, and then touching, under perfect illumi-

¹ Treatise on the Ear, C. H. Burnett, 1884, p. 501.

² Archiv für Ohrenheilkunde, Bd. iv. S. 147.

³ R. W. Seiss, University Medical Magazine, Philada., July, 1889.

nation, each granulation with the point of the probe thus wet with the escharotic. Nothing but the granulation should be touched by this powerful acid. The part touched instantly turns yellowish-white, and the discharge from the ear is usually a little increased for a day or two, owing to the sloughing induced by the caustic. This acid should never be applied to the ear except under the most perfect illumination from the forehead mirror or the forehead electric lantern, and by a skilled hand. Any other course will surely produce a slough in healthy tissue and the ear will be made worse. Fortunately, the antiseptic powder already named will usually cause granulations to disappear without resort to chromic acid. Let it be distinctly understood that the latter should never be applied to the ear on cotton, on the cotton-holder or in any other way, as too much acid will be taken up by the cotton, and, when pressed upon the granulation, more than is required will be pressed out and will run over adjacent tissue.

Polypoid hypertrophy of the mucous membrane of the middle ear, with hernial protrusion through the perforation, is often mistaken for a polypus and treated as such by caustics. Unlike a polypus, such protrusions of mucous membrane are very sensitive to the touch, while true pedicellate polypi are not. This will serve in establishing a differential diagnosis and greatly modifying the treatment. A protrusion of the mucous membrane should never be cauterized nor snared off, as it will disappear under insufflations of antiseptic powders. This I have verified repeatedly. Cauterizing or snaring them is not only painful, but is very likely to set up an acute otitis media.

A true *pedicellate polypus* in the ear is not difficult of diagnosis. After the ear has been cleansed, inspection of the auditory canal and fundus reveals a more or less bright red and shining body either in the fundus, near or upon the membrana tympani, or farther outward in the canal, nearer the meatus, the lumen of which is often filled by the growth by the time it has extended so far outward. A more or less copious and offensive discharge from the ear exists at the same time, and usually it is for the latter that the surgeon's aid is asked.

The first step in the case must be the removal of the polypus, in order to free the ear from the irritation of its presence, to perfect drainage of pus from the middle ear, and to apply medication. Patients must be told that the removal of the polypus is only the first step in treatment, as its pedicle or "root" must be thoroughly destroyed in order to prevent regrowth. If the pedicle is properly treated, regrowth never occurs, though an entirely new polypus might form if the discharge were not checked, or if the ear were entirely neglected as to daily cleansing.

A little cocaine (a five- or ten-per-cent. solution) may be dropped into the ear in order to blunt the sensibility of the walls of the auditory canal and fundus: the polyp itself is insensitive. However, this is not demanded if the operator has skill and his instrument is slender. Furthermore, cocaine does not act readily on the skin-tissue of the external ear.

Patients, however, are often reassured by dropping a solution of cocaine in the ear before a polypus is to be extracted.

Polypus Snare.—The only good surgical means of removing an aural polypus is the so-called polypus snare. This should consist of a slender canula, six centimetres long and one millimetre in diameter, as modified from the Wilde and Blake instruments. The former is entirely rejected at the present day on account of its clumsiness and size. In its original condition it was too large to be convenient, because the width of the shaft and the exposed wires was nearly as great as the canal diameter itself, and hence darkened the canal and filled it up so that the distal end of the instrument could not be seen, in most cases, after it had passed beyond the meatus.

Dr. C. J. Blake confined these wires forming the snare in a canula which flared slightly at the end, and thus at once provided the aurist with a compact polypus snare. Subsequently, Dr. C. H. Burnett narrowed the canula still further and did away with the flare at the loop end, which gave a better view of the fundus and the body about to be seized by the snare. (See Fig. 7.) Across the mouth of the canula is placed a little bar, which prevents the loop from being drawn into the barrel. Various kinds of wires and threads have been employed to run in the canula and form the loop. In the writer's experience no form of wire acts so well in this instrument as that known as brass saddler's wire, used in harness-making. It is bright, fine, and flexible without being too flimsy to maintain a loop, and is quite strong enough to constrict an aural polypus pedicle. Iron and silver wire are too stiff and strong, and hence make loops at once unmanageable and harsh. Sexton's polypus snare is a good one because so slender and light. In this instrument three abrupt turns are given to the wire through notches cut rather deeply in the slide for its reception.

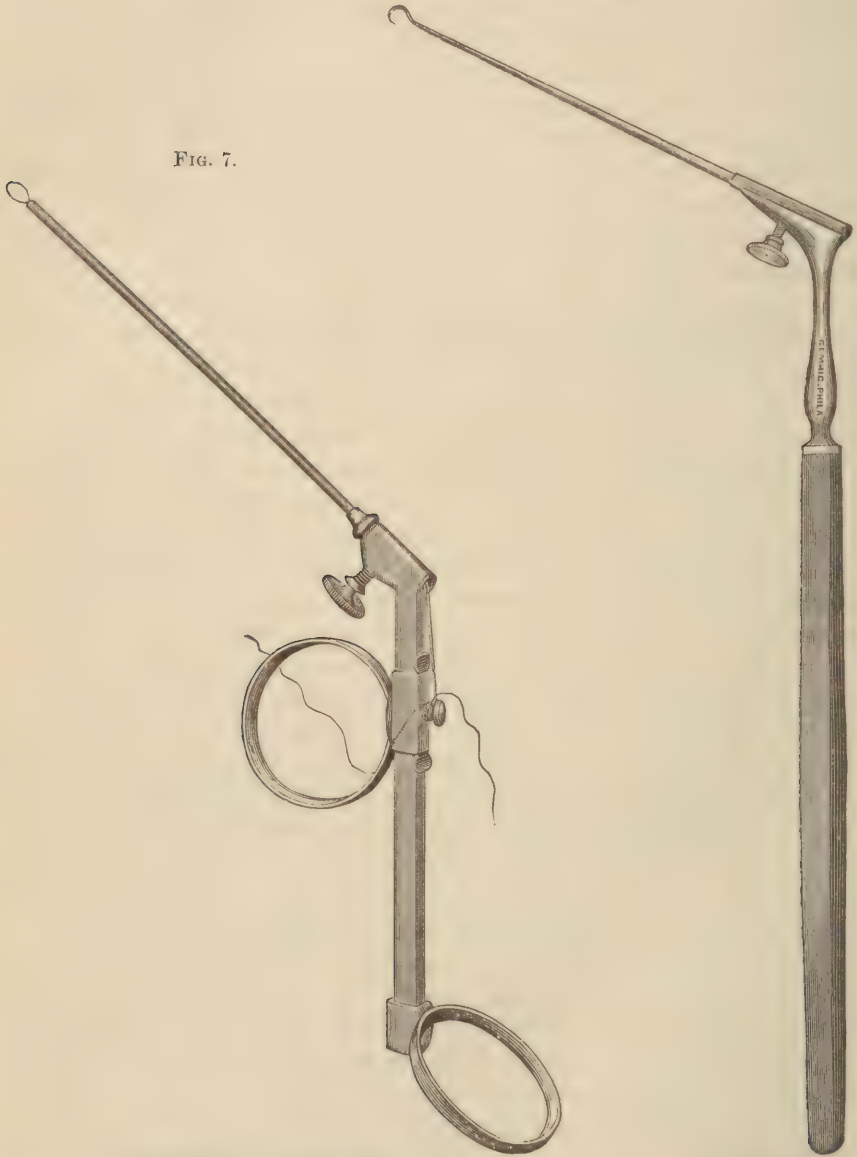
Polypus Hook.—Sometimes small polypi may be caught and removed on a hook made for that purpose. But hooks are treacherous objects in the ear, as in so narrow a place they are likely to catch hold of the walls of the canal and inflict painful wounds, which is avoided in using the slender forms of polypus snares. Therefore, if a hook is employed for the removal of a polypus, it must be very slender and small (see Fig. 8) and used only by the skilled hand under the best illumination of the ear. Polypi cannot be removed from the ear by means of the slenderest forceps. The separation of the blades in the narrow canal (ten to eleven millimetres) is always painful, even if the instrument is most slender and delicate, and if the instrument is of the latter description it could not maintain a hold upon the slippery polyp, even if it by chance obtained it.

The polyp having been examined with a probe to determine where its pedicle is attached, a loop a little larger than the polypus should be formed at the end of the canula, and its plane turned so as to be towards the growth when reached. Generally a polypus in the fundus of the canal will lie over the membrana tympani. In such a case the loop may be turned nearly at right angles to the canula, so that it can be placed over

the polyp without the canula's interfering with a view of the operation. Now a gentle traction on the trigger will draw the loop into the canula and constrict the pedicle. The polypus is almost always retained in the

FIG. 8.

FIG. 7.



Polypus snare. (C. H. Burnett.)

Polypus hook.
(C. H. Burnett.)

tightened loop and is removed with the instrument. If it is not, it can be syringed from the ear or drawn from it with slender forceps or a cotton-holder.

If there is another polyp in the ear it will be revealed after the removal

of the first, and is to be treated in the same way. As it lies deeper, it will require more care and skill to snare the inner one. More or less hemorrhage follows the removal of aural polypi. This is very slight—a few drops—in the removal of small ones. When they are as large as a large pea, or still larger, sometimes from a fluidrachm to a fluidounce of blood may be lost. In any case this can be quelled by hot-water injections into the ear. After the bleeding has ceased and the ear been cleaned, search should be made for the former attachment of the polypus. When this is found it should be touched with chromic acid in the manner already described (p. 423).

Nitrate of silver is contra-indicated because of its tendency to stimulate granulations, not to destroy them. *Monochloroacetic acid* is productive of so much pain, and is so inferior to chromic acid as a caustic, that it is to be condemned in this connection.

After the point of attachment of the polyp has been carefully touched with *chromic acid*, some antiseptic powder, preferably that composed of one part of iodoform and seven parts of boric acid, should be blown into the fundus of the canal, and the ear let alone for twenty-four hours. The next day the ear should be examined, and, if the powder is found to be dry in the fundus of the canal, it should be let alone until the next day, or until discharge reappears. Sometimes this does not reappear, the removal of the polypus being followed by entire cessation of the otorrhœa.

If, however, discharge reappears, the ear must be syringed and rendered as aseptic as possible. Then the seat of the operation must be dried with absorbent cotton and examined to see whether there are any traces of the pedicle. If the polyp has been a large one, the cut surface of its pedicle may require another touching with chromic acid (p. 423) in the course of two or three days, or whenever the whitish slough is detached and the red surface of the cut pedicle can be distinctly seen. Then the same antiseptic powder is to be blown into the ear and the same course of treatment pursued until all trace of the polypus has gone. If the discharge continues after the disappearance of the polypus, it is to be treated as an ordinary uncomplicated otorrhœa.

EXCISION OF THE MEMBRANA AND OSSICULA.

It must be borne in mind that a perforation in any part of the membrana tympani is only a symptom of a deeper disease. On the whole, it is beneficent: it facilitates drainage and medication of the middle ear, and is nature's indication of the path of treatment to pursue. This is the further removal of the diseased membrana and the two larger ossicula or their remnants, if antiseptic and aseptic treatment alone fail to cure the disease in the drum-cavity. It is well to remember that we do not hear with the membrana tympani. It is only one agent in a series of four; the other three being the three ossicula.

When the membrana is in a normal condition it holds the malleus in a proper state of isolation from the incus and favors the transmission of

sound-waves. When, however, it is perforated it becomes retracted, as stated above, and permits retraction of the malleus and incus and impaction of the stapes in the round window. Its inner surface being inflamed, as it always is in chronic purulency, and studded with granulations, it blocks the drum-cavity and favors further septic retention. If the perforation is small, medication through it is difficult and imperfect, and the surgical removal of the membrana and malleus is as much indicated as that of a polypus or diseased tissue and necrotic bone anywhere else. In all cases of chronic purulency of the drum-cavity the malleus and incus will be found more or less invaded by caries. The stapes resists this process a long time. Therefore, if antisepsis fail to check chronic purulency in the drum-cavity, it is irrational and contrary to the teachings of modern surgery not to excise the necrotic elements, thus favoring drainage and also a more perfect medication of the diseased mucous membrane in the drum-cavity. If the stapes has not been invaded by necrosis so as to destroy its foot-plate, the hearing will be improved to a greater or less degree by this operation, even if the rami of the stapes are gone. With the drum-cavity thus cleared, medication, if it has not been too long deferred, will prevent extension of purulency and necrosis to the antrum, the mastoid region, and the vital parts beyond. Like other successful treatment, it is prophylactic of more serious evils.

Excision of the perforated membrana tympani and carious ossicula in chronic purulent otitis media had been performed in a few instances by Schwartze,¹ of Halle, and others² in Germany, when Sexton,³ of New York, revived the operation and greatly improved the methods of performing it by the employment of an anæsthetic and of electric illumination of the ear by means of a head lantern arranged for him.

Subsequently, Sexton's methods were employed by Dr. C. J. Colles,⁴ of New York, and Dr. C. H. Burnett,⁵ of Philadelphia. There is no record of the operation's being performed anywhere else with the patient narcotized by ether and the ear illuminated by electric light, though the operation has of late been performed in Germany, with the patient anæsthetized and the ear lighted by daylight.

When excision of the diseased membrana tympani and of the two larger ossicula is to be performed, the patient must be anæsthetized in order to keep him still and prevent his suffering. In all the operations the writer has performed, ether has been administered.

When thorough narcotism is produced, the operation may be begun. The ear may be illuminated by bright sunlight if it can be obtained. But,

¹ "Die chirurgischen Krankheiten des Ohres," Stuttgart, 1885; operation recorded as done in 1878.

² Stacke and Kretschmann.

³ Transactions of the American Otological Society, 1886.

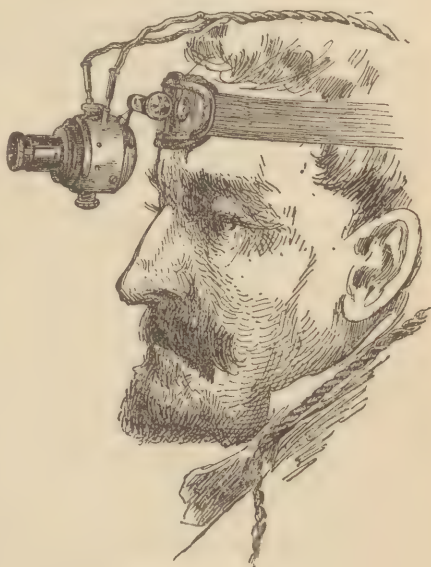
⁴ Deutscher Medicinische Wochenschrift, No. 29, 1889.

⁵ Philadelphia Medical News, August, 1889.

as this form of lighting cannot be had always when and where it is wanted, and as complete and bright illumination of the ear and fundus of the auditory canal are absolutely of prime necessity in the operation of excision, this want has led to the employment of the electric forehead-lamp, as first suggested and elaborated by Dr. Samuel Sexton, of New York.

The lighting apparatus used by the writer consists of the lantern, or illuminator, as it is termed, made of paper, and contains an Edison incandescent lamp of six volts. This is held on the head by a head-band like that used for holding the head-mirror of the laryngologist or the aurist. The lantern is held to the head-band by a ball-and-socket joint devised by the writer. (See Fig. 9.) This joint can be tightened or loosened at will, and holds the lantern wherever desired, away from the nose, thus dispensing with the long metallic arm seen in some other apparatus, which is intended to rest upon the nose. Such an arrangement as the

FIG. 9.



Electric forehead-lamp.

latter is cumbersome, interferes with vision, and may get so hot as to burn the surgeon's nose. The current is supplied by a small portable storage battery of six volts, weighing, when ready for use, eleven pounds and six ounces, made for me by the Electro-Dynamic Company of Philadelphia. It has always been charged from their dynamo-current. The instruments required for this operation are not numerous. They consist of four knives, as shown in Fig. 10, a foreign-body forceps (Fig. 11), and about fifty cotton-holders, supplied with cotton tufts before the operation begins.

In a case of chronic purulent otitis media, with a perforation in the membrana tensa, and if the incus-stapes joint is visible, the surgeon should endeavor to disarticulate the incus from the stapes and remove the former. To do this, the hook-knife or incus-knife, attached to a straight and slender shaft (Fig. 10 D), should be passed between the handle of the malleus and the descending ramus of the incus, and the small hook-blade, one and a half millimetres long by one millimetre wide, thrown over the incus-stapes joint by a gentle turn of the handle between the thumb and forefinger of the surgeon. A gentle downward pressure of this little hook-blade will sever the joint, and the incus can be pulled downward and outward through the perforation by gentle traction with this same knife. At each

step, and in fact between the steps, of the operation the free bleeding always present in chronic purulent otitis media must be mopped away, to allow the surgeon to see what he is doing. The detached incus can now be seized with ordinary slender forceps or with foreign-body forceps and removed from the ear.

If the incus-stapes joint is not exposed by the chronic disease, the round-pointed knife (Fig. 10 A) may be inserted close behind the short process of the malleus and the posterior superior quadrant of the membrana

FIG. 10.



FIG. 11.



Sexton's foreign-body forceps.

excised in order to expose the incus-stapes joint, if possible. It may not be present in cases of chronic purulency, or it may be hidden by swollen tissue, or it may lie too high above the periphery of the drum-membrane to be seen. If it can be discovered it should be severed and the incus removed, as already stated. The incus having been thus removed if discovered, or if it cannot be discovered, the curved tenotome (Fig. 10 C) should be passed behind the short process of the malleus and the tendon of the tensor tympani severed. In chronic purulency the incus has generally long since been destroyed. Then the round-pointed knife (Fig. 10 A) should be swept about the entire periphery, and the malleus handle, or its remnant, should be seized as near as possible at the short process by the foreign-body forceps (Fig. 11) and removed from the ear.

The ossicles thus removed from an ear affected with chronic suppuration are more or less carious or partly destroyed by necrosis. Very often no trace of the incus or rami of the stapes can be found, all these parts having been destroyed by necrosis.

The manubrium of the malleus is sometimes partly or entirely destroyed by the same process, and the inner surface of the remnant of the membrana, as well as the tympanic surface of the remnant of the malleus, is studded with granulations.

After the ear is cleansed, powdered iodoform or iodoform and boric acid (p. 419) should be insufflated into the fundus, and the ear let alone for

twenty-four hours, as in a case of extraction of a polypus (p. 427). In fact, the after-treatment is the same in both instances.

The operation thus removes septic matter from the middle ear, promotes drainage of suppuration, and permits a direct and thorough antiseptic treatment of the tympanic cavity. The diminution or cessation of the discharge following the operation and the marked benefits to health and hearing which ensue are shown in the history of the following cases.

CASE I.—Helen X., aged thirteen years, a blonde, who had not yet menstruated, was brought to me for treatment May 5, 1890. Her father stated that his child had been afflicted with chronic purulent discharge from the right ear for five or six years. The disease had come on originally without any known cause, and had seemed to vary with the child's health, especially being worse with a cold in the head. Periods of six months had elapsed during these years without any discharge from the ear. Several years ago, following an attack of ear-pain, an abscess formed behind the ear, and was opened by a well-known surgeon, giving vent to considerable pus.

The treatment of the ear had been done at home, and consisted in instillations of a solution of boric acid, and, latterly, in insufflations of boric acid powder. Examination of the patient revealed a sunken cicatrix behind the auricle over the region of the mastoid antrum. The membrana tympani was sunken and macerated by a little pus at the fundus of the canal, and there was a perforation in it below and in front. There was a small polyp attached to an exostotic elevation near the upper posterior quadrant of the insertion of the membrana tympani. The hearing was reduced to one inch for the large tuning-fork *per aer*, and for isolated words about six inches. The polypus was removed by the wire snare and its pedicle touched with a little chromic acid. Boric acid was then insufflated and antiseptis maintained by occasional syringing and daily instillations of a bichloride solution¹ for three weeks, but this treatment seemed to increase the discharge.

Knowing of the long treatment with boric acid, and also perceiving that local treatment at my hands seemed to make the discharge worse, and that the perforation in the membrana tympani was too small to permit good drainage from the tympanic cavity, with its swollen mucous membrane, or the entrance of medication to the diseased drum-cavity, I proposed excision of the membrana tympani and the malleus.

The patient was etherized June 11, 1890, and the membrana and the malleus were excised. Granulations were found blocking the drum-cavity, on the promontory, and on the inner surface of the membrana tympani. The hemorrhage was considerable, and the operation tedious on this account and also because the malleus was adherent to the inner wall of the drum-cavity. The head and neck of the malleus were not necrotic, but granulations were attached to the neck. The lower end of the manubrium was destroyed by necrosis. The incus could neither be seen nor felt.

¹ Hydrarg. bichlor., gr. $\frac{1}{4}$; acidi tartarici, gr. x; aquæ, f̄ssiii. (Randolph.)

From this time the discharge became very slight, not enough to appear at the meatus. Antisepsis was kept up by iodoform and boric-acid powder (one to seven) and syringing every few days. In two weeks the hearing was found to have advanced from *ten inches* to *four feet*. During the following two months the ear was syringed once or twice a week with alcohol and water (half-ounce to the pint). In September, three months after the operation, the ear was found to discharge with a cold in the head, but to be quite dry in the interim.

Since then—*i.e.*, for a year—the ear has generally been entirely dry part of each month, to begin again to discharge. The discharge seems to come from the Eustachian region, the anterior part of the inner tympanic wall being red and granular at times. The upper posterior part of the drum-cavity is dry and white, as is the front part of the cavity, part of each month. Air is forced from the Eustachian tube by Valsalva's inflation. As the menses have not been established, the patient being in her fifteenth year, the alternating conditions in the drum just mentioned suggest a vicarious action.

At present the treatment consists in daily instillations of peroxide of hydrogen, the syringing with salt-and-water (five per cent.), and then an instillation of a solution of sulphate of copper (gr. i to f*3*i). The hearing is at present ten feet, measured in the presence of her father.

CASE II.—Mrs. G., of Idaho, thirty-five years old, consulted me July 14, 1891, for chronic purulent discharge from the right ear, and deafness. She is affected with chronic catarrh of the middle ear on the left side. She had scarlatina at four years of age, since which the right ear has discharged. This ear has been treated in some way within the last few years. The patient has always worn cotton in her ear. Examination revealed a large central heart-shaped perforation, with the stump of the malleus, round and red, looking like a polypus. The probe revealed necrosis of the lower end of the hammer handle. Hearing in the right ear, six inches. Hearing in the left ear, eighteen inches.

I at once advised excision of the membrana and necrotic malleus, and the operation was performed, with patient under ether, July 17, 1891.

The malleus handle was found destroyed by necrosis as far up as the short process. The articular surface of the head of the malleus was carious. No trace of the incus could be found, and the caries of the malleus head leads to the supposition that the incus had been destroyed by the same process as removed the malleus head.

Immediately upon recovery from ether the patient heard sounds and voices in the room and in the corridor of the hospital, previously unheard in the right ear. Examination the day after the operation showed the hearing to be eighteen inches for isolated words in the right ear.

The discharge was slight and largely mucous in its nature. The patient was directed to syringe the ear once daily with salt-and-water (five per cent.) and to instil ten drops of peroxide of hydrogen into the ear.

On August 4 the hearing was found to be two feet for isolated words in the right ear, it being now a better ear than the left one.

September 9, 1891, the hearing is from six to eight feet for isolated words in the right ear, and there is no discharge.

CASE III.—Grace H., a waitress, twenty years old, was seen in October, 1891. She has had chronic suppuration in the left ear for a long time; has had pain and increased discharge lately. Inspection reveals great destruction of the membrana tympani and malleus, all having disappeared excepting the anterior half of the membrane bounded above and behind by the manubrium, the rest of the bonelet having been destroyed. This remnant of the membrana, containing the manubrium on its free edge, was easily movable inward and outward by a probe. Inspection of the entire attic and atrium was very easy, and it revealed the absence of all traces of the incus and stapes. The mucous membrane was free from granulations. The upper free end of the manubrium, wanting the short process, was carious, as felt by the probe. On October 21, 1891, cocaine solution, twenty per cent., was mopped into the fundus of the auditory canal; the piece of the membrana tympani was then cut off from the peripheric attachment, and it, with the manubrium, taken from the ear by forceps. A little iodoform and boric-acid powder was blown into the depths of the ear, and let alone for a day or two. This was repeated once or twice, and then the ear was found to be free from discharge. On January 21, 1892, it was found that the ear was not discharging, and that it had not discharged since the operation, three months previous.

The improvement in hearing in the foregoing cases is certainly due to the removal of obstructions to the entrance of sound-waves to the middle ear. After the operation, sound-waves fall more directly upon the stapes and the oval window. The progressive improvement in hearing noted in some of them is due to the gradual overcoming of the ankylosis due to long disuse of the foot-plate of the stapes.

The imperative duty of the aurist is to check a purulent process, especially a chronic one, in the middle ear as soon as possible, not only to save hearing, but to save the health and life of the patient. In numerous instances old methods of treatment by instillation and powders will not do it, notably among those with poor hygienic surroundings. Defiant cases of purulent otorrhœa are common, even among those surrounded by every means of health. Excision of the membrana tympani and necrotic ossicula in cases which have defied all other remedies offers an efficient and prompt means of getting rid of septic material, improving the drainage from the middle ear, and getting directly at the diseased mucous membrane and the tympanic walls with antiseptic medications. In consequence of this operation the hearing and health of the patient will be improved and his chances of prolonged life increased, because of the removal of the risk of deeper tympanic disease, cerebral abscess, sinus-thrombosis, and pyæmia.

PART III.

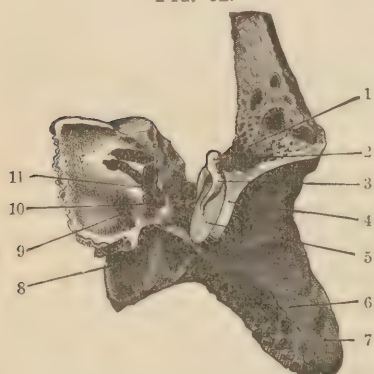
CHRONIC SUPPURATION OF THE ATTIC, OR
RECESSUS EPITYMPANICUS.

Our consideration must now be directed specially towards that form of chronic suppuration of the middle ear originating in and usually limited to the attic space (*recessus epitympanicus*), or upper part of the drum-cavity beneath the tegmen tympani (Fig. 12, ^{1, 2}). These are the so-called "attic cases." They are characterized by a perforation in the membrana flaccida or Shrapnell's membrane (Fig. 2, ^{1, 1}), an imperforate membrana tensa, the part below the folds of the drum-head, and a scanty, offensive discharge, clinging chiefly to the upper wall of the auditory canal. So slight is this discharge in most cases of attic suppuration that the membrana tensa is generally entirely dry, and when the ear is first inspected it appears to be free from secretion. Upon close examination, however, of the upper wall of the auditory canal and the upper part of the membrana, above the line of the folds and short process, a film of pus will be seen. When this is mopped away the perforation in the membrana flaccida will be made apparent. This perforation may be very small, and a small granulation or polyp may lie over it or protrude through it. If it is large, the neck of the malleus may be seen through it, or if a portion of the margo tympanicus—the osseous edge of the squama forming the part of the tympanic ring at the Rivinian seg-

ment—has been destroyed by caries, the entire head of the malleus and part of the body of the incus connected with the malleus may be visible. Sometimes, though this perforation is very large, disease having destroyed the head of the malleus and the incus, the perforation reveals an empty antro-tympanic space.

Membrana Flaccida.—The membrana flaccida may be briefly described as a fan-shaped region, the lower borders of which, or the imagined sticks of the fan, run backward and forward from the short process of the malleus above the upper edge of each so-called fold of the membrana tympani, forming a lower boundary about five millimetres long. (See Fig. 2.) The upper edge of this

FIG. 12.



THE LEFT TYMPANIC CAVITY LAID OPEN AND VIEWED FROM IN FRONT (C. H. Burnett). —1, front mastoid cells and attic; 2, head of malleus in the attic; 3, malleus; 4, annulus tympanicus; 5, membrana tympani (pars tensa); 6, lower mastoid cells; 7, mastoid process; 8, jugular fossa; 9, position of cochlea; 10, stapes in the oval window; 11, the vestibule opened on top.

important part of the membrana tympani corresponds to that peculiar part of the general periphery of the drum-head known as the segment of Rivinus.

The latter is more accurately described as the margo tympanicus ("the scute") or inner edge of the upper bony wall of the external auditory canal, and forms the osseous complement at this point of the annulus tympanicus. The membrana flaccida thus outlined is about three millimetres high, measuring from the short process of the hammer up to the point of attachment of the membrane to the upper osseous wall of the auditory canal. This membrane is composed of only two layers, an outer cutaneous one from the auditory canal and an inner mucous layer from the tympanic cavity and inner surface of the margo tympanicus. Directly behind the central part of the membrana flaccida is the neck of the malleus, the head of which lies behind the margo tympanicus. (Fig. 12,².) The front part of this membrane is stretched over the anterior upper part of the tympanic cavity, entrance to which, at this point, is above the so-called anterior pocket of the drum-head. The back part of this flaccid membrane, behind the neck of the malleus, is stretched over the front end of a long and shallow groove yet to be described, and at this point the membrana flaccida is about two millimetres from the lower part of the body of the incus. This posterior groove-like cavity is wedge-shaped, bounded on its inner side by the upper part of the body of the incus and its short horizontal process, and on its outer side by the inner surface of the margo tympanicus. The edge of the wedge-shaped groove points downward, and its base opens upward towards the tegmen, while in its long diameter it widens and forces a way backward into the tympanic cavity and the mastoid antrum. At its anterior end and on its outer side this groove is covered in from the external auditory canal by the back part of the membrana flaccida. Hence when this membrane gives way at this point, egress is afforded to matter from the upper and back part of the tympanic cavity and from the mastoid antrum.

Various Positions of the Perforation.—Sometimes a perforation in the membrana flaccida is directly above the short process of the malleus, opening into what is termed by Prussak and Brunner a "third pouch of the membrana tympani." In perforations of the *central part* of the membrana flaccida the neck of the malleus is exposed. In anterior perforations of this membrane, entrance is effected directly into the large upper space in the front part of the tympanic cavity, near the tympanic end of the Eustachian tube.

Posterior perforations are usually attended with great discharge and mastoid symptoms; they are also most obstinate and accompanied by profound deafness. Central perforations are most likely to be connected with disease in the external auditory canal, but are less obstinate to treatment and are not usually attended with profound deafness nor so great a discharge.

Anterior perforations are most likely to be connected with disease in the nares, the Eustachian tube, and the tympanic cavity, and they give exit generally to a more copious discharge than any other form of attic disease.

In cases of destruction of the entire membrana flaccida, attended with

erosion of the margo tympanicus, there come into view, directly over the line of the folds of the drum-head, the neck and head of the malleus and the junction of the latter with the incus, the body of the incus with the upper part of its descending crus, and the proximal part of its short, horizontal crus. In such cases of extensive destruction the entire dome of the tympanum under the roof can be viewed by turning the patient's head to the opposite side. There may also be seen the cavity of the upper and front part of the tympanum, and a dark cavity in the back part of the space thus opened around the head of the malleus and body of the incus, which is the entrance to the mastoid antrum.

When the perforation is in the anterior part of the membrana flaccida, Valsalvan or other inflation is likely to produce a characteristic perforation-whistle; but when the perforation is elsewhere in the flaccid membrane, a perforation-whistle is not likely to be produced. This can be readily understood upon reflecting that, except in anterior perforations, the head and neck of the malleus and the body of the incus intervene between the cavity of the tympanum and the perforation. Another peculiarity of these cases of perforation in the membrana flaccida is the absence of perforation in the membrana tympani below the folds. Even when disease in the atrium exists, with purulency in the attic, the perforation in the membrana flaccida is often the only outlet. Doubtless there are cases in which purulency in the atrium, with a perforation in the membrana tensa, is attended with purulency in the attic and a perforation in the flaccid membrane; but the more complete drainage of the drum-cavity offered by the lower perforation renders it very unlikely that the perforation in the flaccid membrane will be large or even continue to exist.

The deafness in cases of attic purulency is explained by the nearness of the suppuration to the ossicles of hearing and their impaired motility thus brought about. Patients with attic suppuration are more apt to suffer from dizziness than those with purulency in the atrium, because in the former instance the suppuration is more likely to irritate the stapes in the oval window, and thence the labyrinth through the tissues of the vestibule.

Perforation in the membrana flaccida always means necrosis in the malleus and perhaps in other of the ossicula auditûs. It is fortunate if this is not attended with necrosis in the margo tympanicus and other parts of the surrounding attic walls.

TREATMENT.

There are three methods of treating chronic purulent inflammation of the recessus epitympanicus, or attic space of the drum-cavity,—viz.: 1. By injection of fluids through the perforation in the membrana flaccida. 2. By the introduction of powders or solids through the perforation, if it is large enough. 3. By excision of the membrana tympani, including the remnants of the membrana flaccida, the malleus, and the incus. The latter has proved to be the only means of a radical cure.

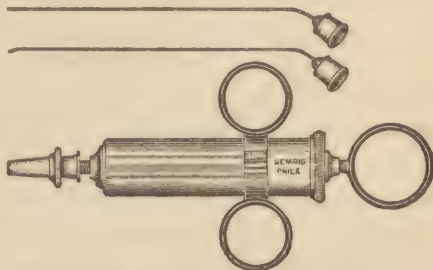
1. *By Injection of Fluids.*—Much relief and even periods of cessation of the discharge may be obtained by injecting antiseptic solutions, by means of the tympanic syringe, through the perforation into the attic space. (Fig. 13.)

The form I use consists in a well-made metallic syringe, about nine centimetres long and one and a half centimetres in diameter, made for me by Gemrig, of Philadelphia. To this may be fitted slender nozzles nine centimetres long, with diameters varying from one-half to one and a half millimetres. The rings for the operator's fingers are adjustable, so that their planes may be brought into the plane of the syringe and nozzle when ready for use in the ear. Only with this instrument can an attic space be thoroughly cleansed or medicated. After the syringe is filled with peroxide of hydrogen, which should not be warmed, as heat decomposes it, the delicate nozzle of the syringe, under perfect illumination, is passed through the speculum, down the auditory canal, and through the perforation in the membrana flaccida. Then, under the eye of the surgeon, the contents of the syringe may be slowly and gently forced into the attic. This is followed by the characteristic foaming produced by the contact of the peroxide of hydrogen with pus. The operation is not painful in any way to the patient, though injections of anything into the attic are usually followed by more or less dizziness. Instead of peroxide of hydrogen, a solution of warm salt-and-water (five per cent.) may be used for cleansing the attic.

After this space is cleansed it may be medicated in the same way by injections of a watery solution of carbolic acid (two and a half to five per cent.) and of sulphate of copper, one to two grains to the fluidounce of water, or with absolute alcohol. Nitrate of silver is not to be used in this way, as it tends to promote granulations and to swell the mucous membrane about the edge of the perforation, thus blocking the way of drainage and medication. As caries and necrosis are always present in chronic suppuration of the attic, either in the ossicula or in the walls of the attic, nitrate of silver is further contra-indicated.

2. *By Powders or Solids.*—If the perforation is two to three millimetres in diameter, some authorities have recommended the insufflation of powders, like boric acid and other antiseptic powders, or the insertion of a small piece of sulphate of copper through the perforation into the attic. The latter I have hesitated to do on account of its painfulness, and the insufflation of powders into the attic I have never found of any value.

FIG. 13.



TYMPANIC SYRINGE.—The coarse nozzle seen in place in the figure is for insertion into a catheter syringe. It is to be removed when the long, slender nozzles are desired for tympanic injections.

They are, furthermore, liable to block this contracted space and lead to very undesirable conditions in the middle ear and mastoid cells.

3. *By Excision of the Diseased Parts.*—Excision of the necrotic tissues in chronic purulency of the attic is indicated just as clearly as excision or resection of necrotic tissue elsewhere in the body.

Excision in a case of chronic suppuration of the attic (antro-tympanic space) is to be accomplished as described already when considering excision in cases of chronic suppuration of the atrium (p. 428). The *membrana tensa* is generally imperforate in a case of typical attic suppuration, the atrium being free from disease also. Therefore the first incision should be made behind the short process, then the superior posterior quadrant of the *membrana tympani* should be excised and search made for the incus-stapes joint. If the latter is found, it is to be cut through and the incus removed as described already (p. 429). Then the tendon of the tensor *tympani* muscle is to be severed, and the entire *membrana tympani* excised by beginning at one side of the perforation in the *membrana flaccida* and running around the periphery to the other side of the perforation leading into the attic. The method of performing this operation and the instruments used are described on page 430. The after-treatment is important, and should be conducted as in any case of chronic purulent otitis media in which there is free access to the drum-cavity.

The advantages of the operation of excision in chronic suppuration of the attic are shown in the following history of cases. This account of cases is given because the entire subject will probably be new and interesting to many readers of this book.

CASE I.—This case came under observation in July, 1888. The patient, a lady of twenty-three, stated that she had had some catarrhal symptoms in her nose, throat, and ears in childhood, that the tonsils were excised, and that this operation was followed by earache and dulness of hearing in both ears. These symptoms soon wore off and were forgotten, except that the right ear, the one now suppurating, never heard well after the excision of the tonsils.

In 1882, six years before first consulting me, suddenly, and without previous warning of any kind, the right ear felt *stopped*. She says that examination by her physician at that time revealed a polypus in the right ear. The polyp was removed, and since then there has been a slight, nearly constant, and offensive discharge from this ear, but hardly enough to flow from the meatus. In the mean time numerous polypi have been removed from this ear, probably from the region of the perforation in the *membrana flaccida*, by surgeons in this country and in Europe, but no permanent relief has followed these operations. This want of success, let me say, was due to the fact that the treatment had been one of symptoms and not of the disease itself, which in reality was a necrosis of the head of the malleus, as shown by the operation I performed.

At the time of the first examination of the case the hearing in the

affected ear was *nothing*. The membrana vibrans was found intact and dry, retracted, white, and shining; in the membrana flaccida there was a large perforation, through which the white neck of the malleus could be seen, and from which a scanty, sticky, offensive discharge came, clinging mostly to the upper wall of the external auditory canal. I, too, then proceeded to treat symptoms, as my predecessors in the case had done, and for one year I applied all known rational means of treatment to the case, by antiseptic injections into the attic cavity with the tympanic syringe, and by snaring off small polypi from time to time as they appeared around the perforation; but all without any good result, simply because I had not reached and could not get at the true disease of the attic, so long as the membrana tympani and the malleus barred the way.

Therefore, on July 29, 1889, the patient was etherized, and, under illumination of the auditory canal by means of the electric head-lamp, the membrana tympani and the malleus were excised. The head of the malleus was found half destroyed by necrosis in its free anterior portion, its articular surface with the incus being normal. The other ossicles were not seen, but as far as could be decided by the probe there were no necrotic spots anywhere else within the tympanic cavity,—an opinion which was strengthened by the speedy healing of the diseased region after the operation.

Here, then, was the cause of the previously incurable purulent discharge from the attic space. The ligaments about the neck of the malleus were very tough and broad, and had acted as a diaphragm between the attic and the atrium, and also as the floor of a sinus running from the diseased malleus head to the perforation in the membrana flaccida.

The steps of the operation of excision in this instance consisted in,—

1. An incision behind the short process, with a slender blade.
2. Through this initial incision a round-pointed blade, curved in the plane of its broad surface, was introduced, and being kept close to the manubrium, below the insertion of the tendon of the tensor tympani, was pressed upward against the latter, and the tendon thus severed.
3. Then a straight blade, with rounded blunt end, was used to cut around the membrana tympani in the annulus tympanicus, thus entirely detaching it, and severing the hammer ligaments at the neck of the bone.
4. Instead of forceps the polypus snare was now used to seize the malleus, being passed around the manubrium, and the malleus with the membrana tympani was removed from the ear.

The slight hemorrhage was controlled by mopping the fundus of the ear with a four-per-cent. solution of cocaine muriate. During the operation the fundus of the ear was mopped frequently with a two-and-a-half-per-cent. solution of carbolic acid. After the operation the meatus of the canal was lightly tamponed with cotton sprinkled with iodoform, and left in place for twenty-four hours.

The next day the patient went about the house. The cotton tampon was slightly discolored on its inner end with a pinkish serum. There was

no purulent discharge. The iodoform tampon in the auditory canal was discontinued in four or five days, and one containing powdered boric acid sprinkled over it was substituted and worn for a week longer. Then simply a little cotton pellet was worn in the meatus, in the open air, to protect the exposed tympanic cavity. On some days the tampon was a little moistened with a serous fluid, but this soon ceased to appear. The absence of any reaction and the tendency to rapid healing in this case I am disposed to attribute largely to the antiseptic measures during and after the operation. By August 12 there was no discharge of any kind from the ear. The hearing was found to be a little improved; about a foot for loud words.

August 19, 1889.—Still no discharge. The mucous membrane of the promontory is pale and rough, but entirely dry. The region of the membrana flaccida is narrowing. Hearing equals a whisper at six inches. The patient now went on a tour to the Adirondacks, free, for the first time in seven years, from the annoyance of a running from the ear and the care it demanded.

The patient was not seen again until September 25, when it was found that a new membrane had formed from the segment of Rivinus, the region of the membrana flaccida, down to the promontory. There was no discharge. The hearing for whispered words was two to three feet.

October 11, 1889.—The delicate membrane, bluish and transparent, rises and falls under gentle suction with the pneumatic speculum. The hearing is *nine feet* for isolated words in ordinary conversational tone.

In August, 1890, *the hearing was fifteen feet for whispered words*, and now, in the summer of 1892, it is the same.

Here is offered an account of a case of chronic purulency and deafness, caused by necrosis of the head of the malleus and altered tension and conductivity in the ossicles, cured of the discharge and the deafness by excision of the useless membrane and a necrotic malleus. The cure of the purulency is easily explained, but the improved hearing is not so easily accounted for. I venture to suggest that the conducting power of the ossicles was interfered with by the presence of pus about them in the attic, and by the pathological bands about the malleus already mentioned, which prevented ready vibration. Also the diseased condition of the head of the malleus loosened its articulation with the incus and impaired its leverage on the latter. Hence a wave of sound falling on the membrana and malleus could not transmit its inward oscillations to the incus and thence to the stapes and the labyrinth.

When the membrana tympani and the necrotic malleus head were removed from the attic, waves of sound fell directly upon the incus and the stapes and were conveyed to the labyrinth. As the new membrane formed and rested against the ossicles remaining, its expansion offered a broader surface to the waves of sound, and possibly helped to increase their leverage on the remaining ossicles, thus transmitting more sound and increasing the hearing. The continuance of this normal stimulus to the movements of

the stapes in the oval window gradually overcame the partial ankylosis which had ensued at that point from disuse, and the hearing, in consequence, has *steadily improved* since the operation from nothing to *fifteen feet* for whispered words.

Let us suppose that the chronic purulency of the attic had been, or could have been, cured by injections through the perforation in the membrana flaccida into the attic cavity. The hearing would not have been improved, because the impaired malleus head and the pathological bands around the neck of the malleus would not have been removed, and hence the impaired mobility of the incus and stapes would still have remained as a hindrance to hearing.

We see, therefore, that the operation of excision of the membrana tympani and the malleus offers a great means not only of curing chronic purulency, especially of the attic, but also of relieving deafness due to a stiffened membrana and ossicles, by the removal of pathological bands prohibiting free oscillations in the ossicles, and by thus permitting sound-waves to fall directly upon the stapes in the oval window.

CASE II.—Mr. W. H. R., aged thirty years, was first seen April 11, 1889, in consultation with his physician. The patient was in bed, where he had been for some days. It was stated that he had had chronic purulent discharge from the right ear since childhood, but that nothing had ever been done for it. Four days previous to the consultation, he was suddenly attacked in the street with nausea and dizziness, attended with a sudden discharge of bloody serum from and pain in the ear. The hearing was reduced to zero; the tuning-fork on the vertex was not heard in the affected ear; the Eustachian tube was pervious to Valsalvan inflation. Examination of the ear revealed a large perforation in the membrana flaccida, covered by a polypus. The malleus was maintained in an upper posterior white remnant of the thickened membrane. Anteriorly stretching from the anterior portion of the annulus tympanicus to the promontory over the tympanic mouth of the Eustachian tube was a thick, red, denuded, and secreting diaphragm, perforated in its centre, through which air and a little mucus would pass upon Valsalvan inflation.

Treatment.—The ear was at once regularly cleaned and antiseptis maintained by injections and instillations of carbolic-acid solution (two and a half per cent.). The vertigo gradually ceased in ten days after I first saw the patient, and he was able to leave the house. The polypus was then removed by a wire snare without pain or hemorrhage and the pedicle touched with a minute quantity of chromic acid. A powder of iodoform and boric acid (one to seven) was insufflated into the ear, and antiseptis maintained for some weeks by insufflation of this powder and injections of the carbolic-acid solution named above. The discharge diminished, and the polypus did not reappear. Upon sudden motion and muscular exercise, as at lawn tennis, the patient would feel considerable dizziness, and he therefore desisted from the game for some weeks. By July 1, two months from the

time of the first examination, the discharge from the ear had become very slight, and the patient went on a journey for two months, using during this time daily instillations of alcohol, but no syringing. By September 1, when the patient returned from his vacation, the discharge was slight, but offensive in odor, coming from the attic of the tympanum. But the use of peroxide of hydrogen and antiseptic injections with the tympanic syringe, into the attic space, several times a week, failed to check the purulency. Neither these nor careful antiseptic instillations by the patient every day at home, continued for months, succeeded in checking the annoying and ill-smelling discharge. Necrosis in the attic was suspected, and the operation subsequently revealed it, as the cause of this obstinate discharge.

Therefore, on June 17, 1890, over a year from the time of the first examination, the patient was etherized, and the remnant of the membrana tympani with the malleus was excised. The hemorrhage was inconsiderable. The head of the malleus was partly destroyed by necrosis. Dense synechial bands were attached firmly to the neck of the malleus, and granulations covered the inner surface of the membrana tympani. A probe passed into the attic revealed an ample space without trace of incus or stapes. There were some granulations in the attic, which were broken up by the probe. Antisepsis by means of peroxide of hydrogen and a solution of carbolic acid (two and a half per cent.), preceded by syringing thrice daily, was kept up by the patient at home. The discharge began to diminish greatly now that necrotic tissue was removed and drainage improved, and in a few weeks the antiseptic treatment was applied only once daily; then every other day, as the discharge diminished; and, finally, only when the discharge was perceived in the ear, which occurred at longer and longer intervals. By March 7, 1891, the ear was entirely free from suppuration or discharge, and has remained so. The attic space is dry and white; the diaphragm in the front part of the tympanic cavity is pale pink and dry, being covered with epithelium. Air passes through the perforation in it without mucus.

The attack of vertigo, pain, and discharge of bloody serum from the ear which first led the patient to give serious attention to his running ear was due, in the writer's opinion, to an irruption of the chronic purulent disease into the vestibule through the oval window. This would cause the sudden vertigo and pain, and the polypus, which bled readily, stained the serum which had escaped from the labyrinth. The cure of the discharge in this case, due entirely to the operation, proved a great benefit to the health of the patient.

CASE III.—Miss F. D., aged forty-eight years, has been annoyed with suppuration in the left attic for years, the discharging pus coming from a perforation in the membrana flaccida, the rest of the membrana tympani being normal. At times there would be collections of cholesteatomatous scales in the attic which would stop the perforation and mechanically check the dis-

charge. This was invariably attended with pain, disagreeable head-symptoms, and depression of spirits. The hearing diminished to nothing. I had seen the patient at long intervals during ten years previous to her visit to me in April, 1890. She then stated that she had been annoyed for some months by a slight, offensive discharge, and that she had removed some flakes (cholesteatomatous) from her ear. Latterly the ear had grown sore and painful, and there was some dizziness. She had heard of excision of the membrana tympani, and asked to have it performed on her, if I advised it. Examination revealed a large perforation involving the membrana flaccida and the segment of Rivinus, in which a large, tough, whitish plug was seen protruding from the attic space. Some of this was picked away, and some more worked its own way from the perforation, after instillations of a solution of bicarbonate of sodium, glycerin, and water. The discomfort in the ear ceased, and it was now seen that the attic space was entirely clear of any ossicles, but its mucous membrane was rough and granulating. The membrana vibrans with the manubrium was seen to form, with the inner tympanic wall, a pocket, in which cholesteatomatous masses had collected, probably at each attack of pain and dizziness. The hearing was nil. Therefore the patient was etherized May 7, 1890, and the membrana tympani with the manubrium mallei was excised. The hemorrhage amounted to about half an ounce. The membrana tympani was very much thickened, its outer surface white and shining; its inner surface was studded with granulations, as was also the mucous membrane on the promontory. The head, neck, and short process of the malleus were destroyed by necrosis. A little iodoform and boric-acid powder was blown into the ear and the ear let alone for a day or two. By May 19, twelve days after the operation, the ear was entirely dry and the mucous membrane of the drum-cavity white and shining. Hearing equals twelve inches for isolated words. June 6, hearing equals eighteen inches for isolated words. The ear has remained in this healthy condition to the present time.

When this case came to me in April, 1890, there was and had been for some time numbness in the tongue on the left side and a subjective metallic taste. This continued for nearly six months, gradually diminishing, and finally disappeared. It was doubtless due to severance of the chorda tympani by the same process as destroyed the incus and the head and neck of the malleus.

There would be very little, if any, mastoid disease, if purulent otitis media in children were promptly cured. In many instances there is no way to check it but to perform excision of the membrana, and thus get at the disease while still limited to the anterior portion of the drum-cavity, and before it has even made a large perforation in the drum-head. At once drainage is improved, and direct medication of the diseased mucous membrane can be carried out. Then antiseptic solutions and powders and in some cases caustics can be applied rationally and with good effect. The hearing will improve, the suppuration will be checked before reaching the attic

or the mastoid, and a new membrana tympani will form, or the mucous membrane of the drum-cavity assume a dry, white, and shining appearance.

Conclusions.—1. The operation has not failed to stop suppuration, or greatly diminish it, in all the cases of chronic purulent otitis media in which the writer has applied it.

2. In attic cases with normal atrium, the sole perforation being in the membrana flaccida, this operation is the *only* means of cure.

3. By this operation, in cases of chronic purulent otitis media, in which the sole perforation is in the membrana tensa, and is comparatively small, and while the purulency is limited to the anterior part of the drum-cavity, the suppuration is promptly checked before it has had an opportunity to attack the posterior portion of the drum-cavity. Thus mastoid inflammation and necrosis, sinus-thrombosis, pyæmia, and cerebral abscess are prevented.

4. If any hearing exists before the operation, it invariably improves after the excision.

5. Vertigo, headache, tinnitus, and the ordinary attacks of earache from “gatherings,” so common in chronic otorrhœa in children, are entirely and permanently relieved by the excision of the necrotic remnants of the membrana tympani and the two larger ossicles.

Exostoses may seriously complicate chronic purulent otitis media by blocking the canal and favoring retention of pus. This is followed by symptoms of septicæmia, demanding the removal of the exostotic obstruction in the canal.¹ If this is not done in such cases, the retained secretion favors further inflammation of the tympanum, affecting the bone and communicating itself to the cranial cavity, where a fatal basilar meningitis may be set up.²

PART IV.

SEQUELÆ OF CHRONIC SUPPURATION IN THE MIDDLE EAR.

The object of this chapter is to give a brief description of the most important sequelæ of neglected chronic purulent otitis media, except mastoid necrosis, in order to enable the physician to make a diagnosis of their presence and nature. It is hoped that the recital of the ravages of chronic purulency in the middle ear will act as a warning against the evils of neglect of this disease and lead to a prompt endeavor to check an otorrhœa as soon as possible. For it is not the checking of a chronic purulency of the ear, but the *not* checking it, that “drives” it to the brain and other vital organs.

The treatment of the sequelæ of chronic purulent otitis media comes very largely within the province of general surgery, especially that part of

¹ See case successfully operated upon by Dr. Robert Barclay, St. Louis Medical and Surgical Journal, February, 1890.

² J. O. Green, Boston Medical and Surgical Journal, April 18, 1878.

it dealing with cranio-cerebral surgery. Mastoid necrosis and its treatment, however, are almost entirely within the domain of aural surgery. In all other cranial or intra-cranial lesions of otitic origin the aurist and the general surgeon can work together with mutual advantage.

The sequelæ of chronic purulent otitis media may be conveniently considered in the following order :

1. Cholesteatoma of the middle ear and temporal bone.
2. Caries and necrosis of all parts of the temporal bone and portions of adjacent bones.
3. Cerebral abscess.
4. Sinus-thrombosis, pyæmia, and embolism in organs other than the brain.
5. Malignant disease of the ear.

Chronic suppuration of the middle ear advances by the successive stages of ulceration of the muco-periosteal membrane, periostitis, otitis, caries, and necrosis of subjacent bones. The interval between the acute stage and these successive chronic stages varies greatly in length. In some instances the acute stage is rapidly succeeded by all the others, even the necrotic exfoliation of some of the parts of the internal ear, while in others many years elapse before the chronic suppurative process in the muco-periosteal lining of the drum-cavity seems suddenly to induce caries and necrosis of the bone beneath, meningitis, encephalitis, sinus-thrombosis, pyæmia, and death. The extension of chronic suppuration to the mastoid region, and the results of caries and necrosis in that portion of the temporal bone, are considered in a separate paper by Dr. Clarence J. Blake, to which the reader is referred.

Paths of Invasion of Surrounding Structures and the Cranial Cavity.—The middle ear or tympanic cavity lies entirely within the temporal bone. Its anterior wall is partly formed by the carotid canal, which is perforated for the passage of filaments of the sympathetic nerve, and its inner wall is the bony partition between the cavity and the internal ear, containing the oval window, part of the facial canal, and the round window. Its floor is formed by the jugular fossa, in which a foramen conveys a branch of the vagus to the drum-cavity. Sometimes this fossa is perforated by an arrest of development in the bone. The posterior wall of the tympanum passes into the mastoid cavity, the inner wall of which is but a thin partition of bone separating the mastoid cells from the sigmoid fossa, in which lies the lateral or transverse sinus of the dura mater. We must note also that the upper and posterior walls of the osseous external auditory canal form a boundary between the brain-cavity and the mastoid cells. Chronic suppuration in the drum-cavity has led in numerous cases to caries and necrosis of any or all of these bony structures in and near the middle ear. Hence it is plain that the brain-cavity and other important structures in the nervous and vascular systems are threatened whenever chronic purulency runs on unheeded and unchecked.

These may be called the gross ways of involvement of the intra-cranial structures by chronic suppuration in the ear. But there are finer, more delicate ways of passage of suppuration from the temporal bone to other parts of the cranium. There are the numerous small nutritious foramina connecting the soft parts of the ear with the dura mater, by which, as can be shown, inflammation does pass from the ear to the brain. Suppuration in the bone may extend to the brain through the internal auditory canal, in which we find prolongations of the dura mater. The petrosal-mastoid canal leads from the mastoid cells to the interior of the skull, forming another way of transmission of inflammation from the ear to the brain. Suppurative inflammation in the ear may invade the brain-cavity by way of the hiatus Fallopii, through the aqueduct of the vestibule, and in children through the petro-squamous fissure and the canals of Verga and vascular canals of Maas, or through the fossa subarcuata, as these portions of the temporal bone in children are unossified and very vascular. It is also said that occasionally inflammation may pass from the ear to the brain "by means of a slit for the dura mater, situated between the epiotic and opisthotic elements, near the aqueduct of the vestibule."¹

On account of these vascular connections between the ear and the cranial cavity, purulent inflammation of the meninges or the sinuses of the brain, thrombosis, and the entrance of septic matter into the circulation may occur without the existence of caries and necrosis in the petrous bone. Therefore a simple purulency of the ear without necrosis must not be deemed a trivial affection.

CHOLESTEATOMA.

Cholesteatoma of the middle ear and deeper parts of the petrous bone may be primary,² but it is most commonly the result of long-continued suppuration in the middle ear. This disease is also known as pearly tumor, and molluscous tumor of the ear and petrous bone. It consists in³ a collection of quite densely packed laminated epithelial cells, undergoing fatty degeneration and intermingled with numerous cells of cholesterine. In some instances these cells are contained in a kind of capsule of connective tissue. (Toynbee.) This accumulation of cells, resembling those of the epidermis, interferes quickly with the escape of the newer cells forming beneath its inner strata, and thereby increases the impaction and pressure of the mass upon the mucous membrane and the underlying bone. This leads to ulceration of the muco-periosteal membrane, the formation of granulations, absorption or erosion of the bone, and the invasion of deeper parts of the cranium. The discharge from the ear is very offensive, there is apt to be pain in the organ if the disease has penetrated to any extent

¹ W. I. Wheeler, M.D., New York Med Abstract, November, 1884.

² Lucæ, quoted by Schwartz, Pathological Anatomy of the Ear (Green's translation), p. 23.

³ Toynbee, Diseases of the Ear, London, 1868.

and is pressing on the surrounding tissues, and often dizziness is complained of by the sufferer.

Cholesteatomatous masses may be suspected in every case of chronic purulency of the ear, as shown by Randall,¹ in an examination of numerous cases of chronic suppurative otitis in mutes.

Virchow² has drawn attention to the fact that nearly one-third of the fatal cases of chronic suppuration of the middle ear are attributable to cholesteatoma.

It is invariably in neglected cases of purulency of the ear—those in which the organ has not been even syringed occasionally—that cholesteatoma is found. And in some instances I have found the meatus narrowed from the constant irritation of the purulency, and the escape of matter thus retarded.

Inspection of an ear containing cholesteatoma reveals a whitish or pale yellow cheesy mass lying in the canal and middle ear. The outer portion is softer and yellower than the inner strata of such a mass, and the odor of all parts of it is exceedingly offensive. As parts of it are removed, excoriations and granulations, bleeding easily, are discovered, and the ear is generally very sensitive to the touch.

In many instances subjects of cholesteatoma in the ear are exceedingly nervous and suffer from neuralgia about the ear and corresponding side of the head, and most of them present more or less well-marked symptoms of septicæmia.

Etiology of Cholesteatoma.—The origin of concentric epidermic masses in the attic, atrium, and mastoid region is considered by Virchow to be due to an epidermoidal transformation of the mucous membrane of the ear. Bezold,³ however, maintains that epidermic cells gain access to the atrium and the attic and thence to the antrum and the mastoid cavity from the external auditory canal through perforation in the membrana tympani. Such an opportunity is offered in chronic purulency of the drum-cavity, in which the membrana is always either perforated or entirely destroyed. Through such a perforation the cutis of the normal auditory canal gains an ascendancy over the diseased mucous membrane of the middle ear, and communicates to it some of its functions, such as the development of epidermic cells. It is the retention of these cells and their decomposition in the deeper parts of the canal and middle ear which lead to the formation of the dangerous cholesteatoma in the ear.

These decomposing masses of epidermis, constantly increased by new depositions of epithelium, exert, partly by pressure and partly by decomposition, a constant inflammatory irritation and perhaps a direct chemical influence on the surrounding bone. The bone is thus rendered sclerotic at

¹ University Medical Magazine, July, 1890.

² Archiv für Ohrenheilkunde, Bd. xxviii., October, 1889

³ Archives of Otology, vol. xix. See American Journal of the Medical Sciences, August, 1891.

some points and is thinned at others, and it may become perforated, thus admitting septic matter to the brain-cavity or lateral sinus or to both.¹

Again, these cholesteatomatous masses in the middle ear may cause embolic processes in other organs, as in a case of a man thirty years old, observed by the writer,² in the Presbyterian Hospital in Philadelphia. In this instance death was caused by embolic abscesses in the liver, with general acute hepatitis. Abscesses were also found in the lungs, and the middle ear and mastoid cells were stuffed with cholesteatoma; but there was no phlebitis of the sinus, nor cerebral disease.

Treatment.—In many instances cholesteatomatous masses may be syringed from the ear by means of warm water. If they are too dense to be removed by this means, they must be softened by instillations of hydrogen binoxide or of a mixture containing sodium bicarbonate, gr. xx; glycerin, fʒii; and water, fʒvi. These should be instilled a little while before syringing and allowed to lie in the ear. Then the syringing, with gentle and patient picking with a probe, will dislodge the mass, or that part of it which is in the external canal and drum-cavity. Impactions in the mastoid cells can be reached and removed only by a mastoid perforation. (See article on Mastoid Disease.)

In any case, after these masses are removed from the more easily accessible parts of the ear, the latter must be carefully cleansed by means of hydrogen peroxide, and the diseased ear treated by antiseptic washes or powders. An ear once thus affected is a menace to the life of the patient, and it must be kept under observation by an intelligent eye.

While not prepared to advise a resort to the operation proposed by Stacke, of Erfurt, for excision of the ossicles, since mastoid disease is not invariably present in every case of attic suppuration, the author feels it his duty to present an outline of this method, although it is chiefly a mastoid operation.

Stacke's Operation.—If caries of the attic wall exists and cholesteatomatous masses are found in it, the mastoid may be, and according to some observers it usually will be, found to be simultaneously affected with caries and cholesteatomatous collections. So convinced is Stacke that attic disease is accompanied by mastoid disease, that he does not first excise the membrana and ossicula and wait to see the result before opening the attic and mastoid antrum. He maintains that in the treatment of suppuration of the attic space the latter should be laid freely open so as to be thoroughly inspected after the removal of the malleus and incus. The method of doing this, as given by Stacke,³ has also the advantage of enabling the surgeon to determine at once whether there is at the same time any disease in the mastoid. The method is as follows. An incision is first made through the soft

¹ Steinbrügge, Archives of Otology, March, 1880.

² See Philadelphia Medical Times, September 1, 1877.

³ Otological Section, Tenth International Medical Congress, Berlin, 1890.

parts down to the bone, following the line of insertion of the auricle, starting from the point of the mastoid process, passing upward and then horizontally forward as far as the temporal region. After the hemorrhage is quelled the periosteum must be dissected or pushed up and away from the incision towards the auditory canal until the bony meatus is exposed. Then the periosteal lining of the canal must be loosened as far as the membrana tympani, and the periosteal cylinder thus obtained be cut through transversely. The cutaneous lining of the canal thus severed must be pushed out of the auditory canal, and, with the auricle and other soft parts, turned forward over the anterior edge of the osseous meatus and held away with retractors.

In this way the entire osseous canal and membrana tympani, surrounded by a small remnant of the cutaneous lining of the canal, are laid bare to inspection. Membrana and hammer are now easily excised, and then the attic is laid bare by chiselling away the lower edge of the squama forming the outer wall of the attic. Then the incus is to be removed and the posterior part of the annulus tympanicus chiselled away as far as the aditus and antrum. All this can be done by direct daylight. When the attic is laid open sufficiently to permit a clear view of its interior, especially of the tegmen tympani, any carious spots must be cautiously but thoroughly curetted. If there are no signs of mastoid disease the operation is done. The auditory canal (cutaneous) is brought back and fastened in position and supplied with a drainage-tube. The skin wound is stitched and heals by first intention. The auditory canal unites. Stenosis has not occurred in the nine cases thus operated on by Stacke. The after-treatment is carried on through the auditory canal, from which the attic space can now be seen.

If, however, during the operation mastoid disease is also discovered, the antrum is further opened by means of additional resection of the posterior wall of the auditory canal. Thus the drum-cavity, the attic, the aditus ad antrum, and the antrum are laid wide open, and all the cavities of the middle ear are easily inspected. Injury of the facial nerve and semicircular canals is avoided if the operator keeps in view the probe lying in the aditus and chisels away only those parts of bone lying on the outer side of it. This wound must now be tamponed (with iodoform), and not stitched.

CARIES AND NECROSIS OF ALL PARTS OF THE TEMPORAL BONE AND PORTIONS OF ADJACENT BONES.

The gravest cases menacing the patient's life are those in which suppuration in the atrium or attic of the drum-cavity, often destroying the membrana, causes caries and necrosis of the inner wall of the tympanic cavity. This result of chronic suppuration can be seen and felt through the perforation when it is large. Often the discharge is scanty in these cases, while in others it is copious and attended with burrowing abscesses behind the auricle or below it in the neck or in the region of the maxillary articulation. Sometimes these abscesses communicate by sinusses with the

external auditory canal. In such instances there may have been many attacks of earache before the patient reaches this stage. Not infrequently such cases, in which there is necrosis of the inner tympanic wall, are attacked by facial paralysis during an acute exacerbation of the inflammation in the ear, and when the patient presents himself for treatment he is a pitiable object. Pyæmic symptoms are often added to those already sketched, and the patient is threatened with cerebral abscess or embolism elsewhere, or with suppurative meningitis in the region of the tegmen tympani.

Whenever a case of suppuration in the ear presents itself, with concomitant caries of the inner wall, great care should be exercised in the selection and application of remedies to the ear. If any remedy is applied roughly on a cotton-probe, or if any caustic, by any means, is now applied to the drum-cavity in the diseased state, there will be great danger of wounding the facial nerve, the canal of which may have a natural gap in it, or one caused by necrosis. Palsy of the facial nerve is the inevitable result, which, indeed, may disappear if the lesion has not been very great; but this accident is always alarming to the patient, and one which should give the surgeon who causes it mortification and anxiety. Caustics are contra-indicated in necrosis, and the surgeon treating the case should carefully determine whether it is present before he applies a caustic to the drum-cavity.

The prognosis in facial palsy arising in the course of an acute attack of otitis media, in a subject of chronic purulency or in one free from the latter malady, is favorable, as it is usually due to engorgement of the sheath of the nerve in the aural portion of its course. But the prognosis in a case of facial paralysis due to the application of an irritant to a suppurating drum-cavity is always grave, because the lesion may have partly or entirely severed a nerve already exposed by erosion of its osseous canal by the chronic tympanic suppuration.

Annular Sequestrum from the Fundus of the Auditory Canal.—As a consequence of chronic suppurative otitis media, necrosis of the wall of the canal near the membrana tympani occurs. Usually this scales off in small pieces, but in one instance the writer observed an annular sequestrum, forming about three-quarters of a circle, thrown off from the inner end of the osseous canal. The patient was a young married woman about thirty years old, pregnant at the time. She stated that she had had a chronic discharge from her ear since childhood. Granulations were observed in the fundus, and a probe introduced for cleansing struck against a whitish, loose piece of bone. This was seized and removed easily with forceps, and proved to be the above-named annular sequestrum. The discharge diminished greatly at once, but the case passed from observation in a few days, and the subsequent history is wanting.

Hartmann¹ narrates a case in which a sequestrum, composed of part of

¹ Medicinische Wochenschrift, No. 48, 1877.

the posterior wall of the auditory canal and mastoid cells, passed into the tympanic cavity and was thence removed. It had formed in the course of a year from the time of the first discharge.

Chronic suppurative otitis media may lead in the course of two years to caries of the malleus and of the inner wall of the tympanic cavity, burrowing, subauricular abscess discharging into the external auditory canal, with total deafness, as in the case of a boy fifteen years old recently observed by me. The only cause assigned for the beginning of the disease in the ear was a habit the boy had of picking it with a pin. Three months before I saw him in consultation with his physician, he had grown pale and thin, and had coughed for a year. Finally, emaciation and weakness became very great, his skin became "muddy" or putty color, and he tottered and moaned as he walked about the room. There were found, at the consultation, chronic purulent rhinitis, rhino-pharyngitis, and pharyngitis with suppurating follicles, almost *greenish pallor* of the face, and extreme irritability of temper. There were many complaints of pain in the belly in the region of the mesenteric glands, with headache and earache at times. The patient now desired to remain in bed, and he had rigors followed by fever every night. His appetite was impaired, and his bowels were irregular, inclined, however, to constipation.

Examination of the ear revealed almost entire destruction of the membrana tympani, a carious remnant of the malleus dangling from the fibrous axis-band, movable in all directions by a probe, and extensive necrosis of the inner tympanic wall. There was also a subauricular abscess opening into the external auditory canal, near the junction of the cartilage with the bone of the canal. There was no history of struma or phthisis in the patient's family. Both parents and all the children living and healthy. The ear was kept clean with antiseptic washes of carbolic acid and bichloride of mercury. The naso-pharynx and the nares were sprayed with simple antiseptic and alkaline solutions. In fourteen days from the time the boy was first seen by me, facial paralysis developed on the side of the diseased ear. The patient grew weaker, and remained in bed, complaining of constant pain in his bowels, until the time of his death, two weeks after the development of facial paralysis. No autopsy could be obtained.

The mixed symptoms of sluggish cerebration, discolored skin, and tendency to constipation and emaciation, with rigors and fever on the other hand, in this case, would indicate cerebral abscess complicated by general septicæmia. It seems to have been a case in which early treatment of the purulent ear-disease could have prevented the caries and necrosis in the tympanic cavity and the resultant cranial and pyæmic symptoms, with their fatal ending.

The long duration of the constitutional symptoms would tend to indicate not only the presence of an abscess in the brain, but also the peculiar tolerance shown sometimes by the system to the presence of such a cerebral lesion.

Exfoliation of the Cochlea.—Exfoliation of the cochlea, as a sequestrum separate from the rest of the labyrinth, has been observed and described by a number of authors.¹ In the vast majority of these cases the cochlea was taken out or came out spontaneously during life, the patient, of course, remaining totally deaf in the affected ear, but free from facial paralysis, as the cochlea lies in front of and separate from the bony tissue above the vestibule through which the facial canal runs. In two cases, one given by Boeck² and one by Ménière,³ the necrosed cochlea was found after death as a free sequestrum in the external ear. Boeck's case presented the unusual feature of facial paralysis, of course due to necrosis extending backward towards the vestibule. The patient, a child under two years of age, succumbed, during the progress of the necrotic disease of the internal ear, from acute hydrocephalus. In all these cases the exfoliated cochlea was removed through the external auditory meatus. Not uncommonly, before the acute symptoms preceding the detachment of the sequestrum, the external ear and mastoid portion are free from pain or tenderness on pressure,—a very marked, though not an invariable, diagnostic difference between deep-seated inflammation of the labyrinth and mastoid disease. Sometimes detachment of pieces of the bony auditory canal precedes the exfoliation of the cochlea. Facial paralysis is rarely observed, and never permanent if it occur when the cochlea alone is thrown off. From recorded accounts it appears that only Toynbee observed this symptom during life in connection with exfoliation of the cochlea alone. Necrosis and exfoliation of both cochleæ have been observed only by Gruber.⁴ The patient, a lad twelve years old, who had been the subject of chronic otorrhœa for several years after scarlatina, showed no signs of facial paralysis, but was entirely deaf. Thies⁵ has recorded two cases of necrosis of the cochlea, observed by him in the aural clinic of Trautmann, in Berlin. Both cases presented facial paralysis at first; but one recovered after the exfoliation of the cochlea, while in the other the facial paralysis was permanent. The latter condition is the rule in all these cases. There is always absolute deafness and vertigo, and subjective noises continue for a long time, though, it may be, only to a slight extent.

Exfoliation of the Cochlea, Vestibule, Semicircular Canals, and deeper parts of the Internal Ear.—Large sequestra composed of not only the cochlea, but the rest of the labyrinth, the porus acusticus internus, and the major portion of the rest of the temporal bone, have been removed from the ear during life in subjects of chronic purulent otitis media.⁶ In two cases reported by Toynbee, the sequestra were not removed until after death, which

¹ Ménière, Gruber, Hinton, Toynbee, Cassells, Parreidt, Boeck, Denuert, and Lucæ.

² Archiv für Ohrenheilkunde, Bd. ix., 1875.

³ Gazette Médicale de Paris, No. 50, 1857.

⁴ Lehrbuch, p. 542, 1870.

⁵ Archiv für Ohrenheilkunde, Bd. xxx., 1890.

⁶ Wilde, Shaw, Toynbee, C. R. Agnew, Voltolini, O. D. Pomeroy, C. J. Blake, and Samuel Sexton.

occurred in consequence of the severe and previously-neglected aural disease. In the other cases the large sequestra were removed through the external meatus, except in the case reported by Pomeroy, in which the sequestrum, consisting of the major part of the temporal bone, came out by a natural process from the opening of a sinus behind the auricle. Implication of so much of the temporal bone as occurs in the formation of such large sequestra is naturally attended with facial paralysis as a markedly characteristic symptom, besides profound deafness. In addition to the invariably ensuing facial paralysis, which may be permanent, there may occur temporary paralysis of the arm and leg on the side of the diseased ear (Wilde). The latter paralysis, however, vanishes upon the cessation of the acute symptoms, and may be considered as due to pressure from the pus retained in the ear.

All the symptoms of necrosis and exfoliation of the cochlea are intensified when necrosis involves other parts of the labyrinth and adjacent temporal bone. Not only are the deep-seated pains in the ear, tinnitus, deafness, vertigo, nausea, and vomiting urgent symptoms, but the external ear is tumefied and more sensitive to pressure; the mastoid portion is more apt to become tender and painful, and an abscess may form at that point, and, opening, leave a sinus, which leads to dead bone. The discharge is excessively fetid; the cerebral symptoms are often alarming; the gait may be altered for long periods, as in a case reported by Sexton. Convulsions and coma may supervene and death occur, as in two cases reported by Toynbee. In one of these last-named cases an opening was found leading from the sequestrum in the posterior part of the petrous bone to the jugular fossa. In necrosis originating in the inner wall of the tympanic cavity, there seems to be a tendency on the part of the disease to enucleate the hard and resistant labyrinth from the surrounding more porous petrous bone in which it lies embedded. Dr. H. N. Spencer¹ observed a case in which the cochlea and part of the posterior semicircular canal were removed as a sequestrum by forceps from the external auditory canal of a boy. There was no facial paralysis. There were marked pyæmic symptoms, from which the patient recovered.

The *facial paralysis* following necrosis of the labyrinth, and even when the entire labyrinth is thrown off as a sequestrum, may partly² or entirely³ disappear. It is not safe to leave the paralysis of the facial nerve entirely to nature, as muscular degeneration is advancing in such cases, and re-establishment of innervation becomes more doubtful the longer it lasts.

However, facial paralysis occurring in the course of chronic suppuration of the middle ear, without an acute intercurrent process in the ear, must be considered a grave symptom. Thus, Sexton records⁴ two fatal cases in children: one with *facial paralysis* and *pachymeningitis*; another

¹ Report of the Medical Society of Missouri, April 21, 1875.

² Dr. Charles A. Todd, Transactions of the American Otological Society, vol. iii.

³ Dr. F. L. Jack, Boston Medical and Surgical Journal, March 29, 1888.

⁴ American Otological Society, 1885.

with lymphadenoma of the neck, caries of the atrium, attic, antrum, and the tympanic and auditory plates, facial paralysis, and purulent meningitis.

Paralysis of the facial nerve may take place during caries of the mastoid, as observed by the writer¹ in a lad fourteen years old. In this case a large sequestrum was removed through an incision in the skin behind the auricle, after which the suppuration in the ear ceased and the facial paralysis disappeared.

Not only facial paralysis, but also paralysis of the sixth nerve and of the ophthalmic branch of the fifth nerve, may be induced by necrosis in the tympanic cavity, resulting from chronic purulency in that space.² In this case it was found that a round-celled sarcoma had formed in the middle ear. Double optic neuritis and atrophy of both optic nerves were observed in the case of a girl, eleven years old, suffering with mastoid necrosis.³

Chronic suppuration of the middle ear may lead to caries of the carotid canal and rupture of the internal carotid artery.⁴ One case of death from this cause is recorded by Dr. G. Newton Pitt⁵ as occurring in Guy's Hospital. Some years ago Politzer had collected only fourteen recorded cases of this accident resulting from chronic suppuration of the middle ear.

FIG. 14.



Extensive necrosis of the adjacent occipital, temporal, and parietal bones in connection with disease of the mastoid cells, and ending in fatal meningitis,⁶ may be the result of chronic purulent otitis; or necrosis of nearly all the petrous bone and parts of the parietal and sphenoid, with disintegration of the maxillary articulation, has occurred before death was caused by a cerebral abscess, as shown in Fig. 14.

In this instance death was caused by an encysted cerebral abscess which

¹ Philadelphia Medical Times, May 22, 1875.

² George C. Harlan, M.D., Philadelphia Medical Times, December 13, 1873.

³ Charles Shaffner, M.D., Philadelphia Medical News, January 5, 1884.

⁴ T. Y. Sutphen, M.D., Archives of Otology, vol. xv. No. 4, 1886.

⁵ Goulstonian Lecture, British Medical Journal, March 22 and April 5, 1890.

⁶ Samuel Ashhurst, M.D., Medical Times, April 26, 1873.

had lasted nearly a year. In viewing the base of the skull it was seen that an area of bone three inches long by one and a half inches wide, where the pyramid of the petrous bone had been, was destroyed by necrosis. In the middle fossa of the skull was the cerebral abscess, containing about a fluidounce of pus.

In this case there were noted pain in the head, months before death, facial paralysis, a peculiar dirty-greenish pallor of the skin, dulness of intellect, great weakness, and finally intense pain in the head, which was followed by coma and death, forty years after the beginning of the purulent otorrhœa and about a year from the appearance of the more acute and threatening head-symptoms.¹

In a series of nearly nine thousand autopsies made in Guy's Hospital, during a period of twenty years, it is shown that chronic purulency in the ear was the cause of intra-cranial lesions in fifty-seven instances.² In two instances chronic purulent otitis produced fatal extra-cranial lesions,—one, rupture of the internal carotid canal and artery; the other, a retro-pharyngeal abscess. According to the tables of the Registrar-General of England, there were three thousand five hundred and seventy deaths from "otorrhœa" during the years 1878 to 1887 inclusive.³ This is equivalent to three hundred and fifty-seven deaths a year from ear-disease. Mr. Barker thinks, however, that, with careful examination, this number would be swelled to four or five times that amount.

The left ear seems to be affected more frequently than the right. The acute process in the chronically diseased ear is set up sometimes apparently spontaneously; in other instances the exciting cause of the final acute and fatal process is a cold, exposure to cold water or cold air, a blow, or mastoid suppuration. This causes a swelling of the mucous membrane, increase in granulations, and a blocking of pus; and it is pus under tension that does the harm.

The observations of later investigators have, on the whole, confirmed Toynbee's views that (1) affections of the external meatus and mastoid cells produce disease in the lateral sinus and cerebellum; (2) affections of the tympanic cavity produce disease in the cerebrum; and (3) affections of the vestibule and cochlea produce disease in the medulla oblongata and meningitis in the posterior fossa of the skull. However, thrombosis of the lateral sinus has often originated from caries of the posterior wall of the tympanic cavity, and mastoid disease has sometimes spread to the middle fossa of the skull (Pitt).

Observations⁴ of later years have proved that caries of the bone in the middle ear is not absolutely necessary for an extension of inflammation

¹ See Transactions of Philadelphia Pathological Society, 1883, 1884, p. 236: Hinsdale.

² Goulstonian Lecture, G. Newton Pitt, M.A., M.D., F.R.C.P., British Medical Journal, March 22, 1890.

³ Hunterian Lecture, Arthur E. J. Barker, F.R.C.S., June, 1889.

⁴ J. Orne Green, M.D., Boston, 1877.

from the ear to the brain, because simple inflammation may extend along the numerous channels of communication between the ear and the brain.

CEREBRAL ABSCESS.

Ear-disease is the commonest cause of cerebral abscess. Gull and Sutton say one-third of all cases, and Lebert places it at one-fourth. Pitt reports three abscesses in the cerebellum,—one in the pons, two in the centrum ovale, and twelve in the temporo-sphenoidal lobes. In only two of these temporo-sphenoidal cases was the dura mater over the anterior surface of the petrous bone healthy. In eight it was sloughing, in two it was inflamed, and in one there was a localized extra-dural abscess. In two instances the dura on the posterior surface was also diseased. When there is healthy brain-tissue between the abscess and the bone, it is probable that the infection has been spread by the veins which empty into the superior petrosal sinus from the temporo-sphenoidal lobe on the one hand and the tympanum on the other, by means of a septic phlebitis, or more probably by means of the perivascular lymphatics. Frequently the brain adheres to the anterior surface of the petrous bone, over which the dura is inflamed, and thence infection spreads to the brain.

Symptoms.—The symptoms of cerebral abscess are often vague for a considerable time,—when they may be termed latent. In one instance given by Pitt the symptoms lasted over a year. In a case reported by the writer (see p. 454) the symptoms had been observed for fully a year. During this period headache, vomiting, and a slow, dull mental condition are usually present. Other symptoms have been noted, such as restlessness, lethargy, drowsiness, irritability, delirium, convulsions, earache, emaciation, and slow cerebration. Rigors, when noted, have been found to be due to an associated lateral sinus-thrombosis. Sluggish cerebration is considered by Mr. A. E. J. Barker to be the most characteristic symptom of cerebral abscess.¹

Chronic purulency of the middle ear, without producing caries of the inner tympanic wall or mastoid, may involve the labyrinth and lead to abscess of the cerebellum.² In such cases, according to Bruce, the bacteria, on reaching the dura mater, probably set up a localized meningitis, and shortly after that, or coincidentally with it, infect the cerebellum itself, setting up a septic inflammation which ends in the formation of a fetid abscess and sloughing of the dura mater. The channel of infection of the substance of the cerebellum is probably the perivascular lymph-spaces, and not the blood-vessels. Occlusion of the lymph-spaces by leucocytes, as found in a case reported by McBride, leads to the formation of a thrombus in a vessel, and, from the pressure thus thrown on collateral vessels, to punctiform hemorrhages in the brain-substance. These lesions, together, would lead to malnutrition and abscess-formation in the brain.

¹ Hunterian Lecture, June, 1889.

² P. McBride, M.B., and Alexander Bruce, M.B., *Journal of Anatomy and Physiology*, vol. xiv.

Pitt's¹ conclusions are :

1. Abscesses in the temporo-sphenoidal lobe, which is by far the most common situation, are often associated with an inflamed or sloughing dura mater over the anterior surface of the petrous bone, or with a collection of pus beneath it.

2. Other complications are infrequent, except meningitis, which is generally due to the extension or to the rupture of the abscess.

3. These abscesses are almost always situated very close to the roof of the tympanum.

4. A foul discharge (from the ear) is often a source of danger, and frequently, if not invariably, the spread of the mischief is due to imperfect drainage of the middle ear.

5. Mastoid suppuration often infects the posterior surface of the petrous bone, but it may be associated with disease limited to the middle fossa of the skull.

6. Cerebral abscesses occur only when the otorrhœa has lasted for months or years.

7. The symptoms usually come on insidiously.

8. Rigors, pyrexia, and optic neuritis are all infrequent in uncomplicated cases, but they all occur occasionally.

9. A headache of intense severity and a dull, sluggish mental state are the two most characteristic symptoms.

10. Cerebellar abscesses are less common, and will probably be associated with disease of the dura mater behind the petrous bone, or with thrombosis of the sinus.

Mr. A. E. J. Barker's² views on diagnostic points may be condensed as follows :

Simple cerebral abscess is accompanied by a slow *pulse* of even rhythm and good volume. Meningitis produces a rapid pulse of small volume and often of considerable irregularity, which increases as the case approaches a fatal termination.

The *bowels* in cerebral abscess and meningitis are confined, except as death approaches. In pyæmia and thrombosis there is generally diarrhœa.

Early *vomiting* with much fever is probably due to affections of the lateral sinus with septic infection. If vomiting appears later, with a normal or subnormal temperature, we may conclude that it is due to abscess in the brain or cerebellum.

In meningitis, with its high temperature, we also find early vomiting. But in such a case the rapid onset of delirium or coma will aid in deciding against pyæmia, especially if there are no recurring rigors.

Slow or sluggish cerebration denotes cerebral abscess rather than any other cerebral lesion. *Emaciation*, too, where there is no high fever or

¹ Loc. cit.

² Hunterian Lecture, June, 1889.

diarrhœa, may be of great value in aiding our diagnosis in many cases. If there are constipated bowels, slow cerebation, headache, and low temperature, especially if the latter be subnormal, our suspicion of cerebral abscess as the complication of the ear-affection is strengthened by the appearance of rapid emaciation. The intense *fetor of the breath* noted in cases of cerebral abscess indicates a suspension of digestion with decomposition of food in the stomach. The rapid emaciation is now easily accounted for. With emaciation in abscess of the brain there is often observed a peculiar loss of color or "*muddiness*" of the skin. (See cases, p. 451, 455.)

Treatment.—According to Pitt, the objects to be aimed at in treatment are—(a) in every case to improve drainage of the ear by gouging away or trephining the mastoid sufficiently to open up the horizontal cells or antrum, where pus is often found, and to break a hole through the deeper part of the posterior wall of the external meatus, so as to allow no secretion to be retained. The cavity should be rendered sweet and aseptic as soon as possible. In a case of chronic otitis media it is often desirable to do this as soon as there is evidence of a fresh accession of severe inflammation. Should further exploration be necessary later on, the risk of infection from septic otorrhœa will be very much reduced. It is always desirable that the external ear should be dressed apart from other openings, if any are made. (b) To expose the anterior surface of the petrous bone, so as to allow free drainage for any pus or *débris* which may have formed in connection with the dura mater, which is often inflamed or gangrenous. This is best reached by trephining at a point half an inch above the anterior margin of the external meatus. (c) To drain the abscess from below when possible. It is needless to say that these indications are to be carried out by a general surgeon, and to treatises on cranial surgery the reader is referred. Abscess of the brain may become encysted and life continue for a long time thereafter, as in cases given on pages 451, 454. It is highly probable that a timely operation would save many cases which finally perish from cerebral abscess which is either not recognized or is neglected through fear of surgical interference in the cranial cavity. Every aurist should be able to recognize the various intra-cranial sequelæ of purulent otitis, and be ready to invoke the aid of the general surgeon.

PHLEBITIS AND THROMBOSIS.

According to Pitt, the condition both of the wall of the vein and of its contents varies. In some instances there is well-marked phlebitis. In considerably more than half of Pitt's cases the thrombus was suppurating. However, without breaking down, in some instances the thrombus had set up pulmonary pyæmia. In nearly half of his cases of thrombosed sinus the disease had spread directly from caries or necrosis of the posterior wall of the tympanum,—a fact of great importance. In over seventy per cent. of these cases death occurred from pulmonary pyæmia. As with cerebral abscess, otorrhœa will be found to have lasted for months or years in all cases

of sinus-thrombosis. "In no other complication are erratic pyrexia and rigors so constantly present, and it will always be justifiable to assume that they probably indicate thrombosis in any patient in whom freely opening the deeper mastoid cells and draining the ear have not been followed by their subsidence." Prompt action is necessary, because death in such cases usually occurs within three weeks of the onset of the symptoms. *Earache*, as distinct from *headache*, is more common than in meningitis of cerebral abscess. Other symptoms may be vomiting, coma, listlessness, giddiness, delirium, and convulsions; more rarely diarrhœa, emaciation, acute nephritis, and paraplegia.

Optic neuritis is more suggestive of sinus-thrombosis than of any other lesion.

Mr. Pitt's¹ deductions are :

1. Sinus-thrombosis more often spreads from the posterior wall of the middle ear than from the mastoid cells.
2. The otorrhœa is generally of some standing, but not always.
3. The onset is sudden, the chief symptoms being pyrexia, rigors, pain in the occipital region and in the neck, associated with a septicæmic condition.
4. Well-marked optic neuritis may be present.
5. The appearance of acute local pulmonary disease or of distant sup-puration is almost conclusive of thrombosis.
6. The average duration is about three weeks, and death is generally from pulmonary pyæmia.

Treatment.—According to Horsley, Godlee, Lane, Pitt, Barker, Ballance, and others, the internal jugular vein should be ligatured in the neck and the lateral sinus opened, and if the clot be foul and septic, it may be scraped out, rendered aseptic as soon as possible, and if desirable the sinus may be irrigated. Sometimes it may be well to ligate the jugular vein low down in the neck and seal it. Then, higher up, the vein may again be ligated and divided, and the upper end brought out, so that if septic matter has passed downward it may escape externally. This alone can avert impending pulmonary infection. Mr. Ballance² has operated four times in this manner for the relief of sinus-thrombosis, with two recoveries. In this country, Keen³ has operated once, but the patient, previously much reduced, died from pulmonary embolism. There was no autopsy.

"Thrombosis of the cavernous sinus shows itself by a congestion of the veins which empty into it, the ophthalmic and its branches. . . . As a result of the congestion of these veins there is, on the affected side, œdematous swelling of the nostril, forehead, and eyelid, mechanical hyperæmia of the retina, with diminution of vision, and also swelling of the nasal mucous membrane, with bloody discharge."⁴

¹ Loc. cit.

² British Medical Journal, April 5, 1890.

³ Times and Register, New York and Philadelphia, December 20, 1890.

⁴ J. Orne Green, M.D., Boston, 1877.

Dr. Green also states that, in consequence of a phlebitis of the cavernous sinus, in addition to the above symptoms there are phenomena of irritation and paralysis of the abducens, the ophthalmic branch of the fifth, and the oculo-motorius nerves, due to swelling of the sinus walls and of neighboring tissues. Hence we find internal squint, pain in the forehead over the eye, epiphora, photophobia, and ptosis. Also in thrombosis of the superior longitudinal sinus there are repeated violent hemorrhages from the nose, from the back pressure on the veins of the nasal cavity which empty into this sinus, and also epileptiform convulsions with loss of consciousness, referred by Wreden to capillary hemorrhages in the cortical substance of the convexity of both posterior cerebral lobes, brought on by the interference with the blood-current from the surface of the brain.

"Thrombosis and phlebitis of the transverse sinus show themselves by enormous cedematous swelling of the soft parts in and about the external ear, which has exactly the character of phlegmasia alba dolens."

As the phlebitis extends downward to the internal jugular vein, the external swelling spreads from the mastoid region downward towards the clavicle. The greatest swelling and tenderness are along the course of the vein. Congestion of the facial vein and puffiness of the face may be evanescent symptoms. If, however, the inflammation extends into the facial vein and its larger branches become plugged, enormous edema of the face may appear, with erysipelatous conditions in some instances.

"With phlebitis of the internal jugular vein there is a remarkable dilatation of the external jugular vein, with a distinct undulatory increase and diminution in fulness, accompanying respectively expiration and inspiration."¹ But this is only temporary, because due to blocking of the collateral circulation.

A thrombus in the bulb of the jugular vein may so press upon the spinal accessory nerve in the jugular foramen as to cause irritation of this nerve and resulting tonic and clonic spasms of the sterno-cleido-mastoid and trapezius muscles.

Thrombosis and phlebitis of the superior petrosal sinus cause congestion of the labyrinth of the internal ear, with subjective noises, deafness, and great diminution or total loss of bone-conduction of sound, because the veins of the labyrinth drain partly into this sinus.

MENINGITIS.

This is the most fatal complication in patients under ten years of age, so that it may be said the younger the patient the more likelihood there is of the occurrence of meningitis. It is generally secondary to some other complication, such as pus outside of the dura mater, on either the front surface or the posterior aspect of the petrous pyramid, sloughing of the dura, or a rupture of a cerebral abscess.

¹ J. O. Green, M.D., *loc. cit.*

Symptoms.—The onset is sudden and the course rapid. The temperature is raised, averaging about 101° in Pitt's cases, but in some it was very much higher towards the end. There is generally headache, but not of a severe character like that in cerebral abscess; earache occurs frequently; the patients are lethargic, drowsy, and drift into coma. Vomiting and restlessness are frequently observed. The optic disks are usually normal. The rarity of optic neuritis in meningitis is probably due to the fact that it requires five or six days for its development, or longer when the meningitis is limited to the posterior fossa (Pitt). But in nearly half the cases meningitis proves fatal before the lapse of so much time,—before, in fact, the neuritis can be developed. Motor disturbances, such as convulsions, tremors and twitchings of the limbs, hemiplegia and paresis of the arms, occur often; ptosis, facial paralysis, strabismus, and dysphagia have been observed less frequently. In a number of cases retraction of the neck, with rigidity, is well marked. Occasionally aphasia, agraphia, impairment of memory, emaciation, and a *slow* pulse have been noted in meningitis.

Two forms of meningitis from inflammation of the ear are found. One is infection by absorption into the circulation, the exact path by which the morbid material is carried from the ear to the meninges not being known; the other is an extension of inflammation *ex contiguo* from the bone to the dura mater and thence to the other meninges. The former is a rapid process, and, once established, is necessarily fatal; the latter is a gradual process, “in its incipency localized,” and is occasionally cured.¹

In the majority of cases of fatal meningitis and other cerebral lesions, reported by Gradenigo,² tympanic lesions were found, at least on one side, in the form of mucous, purulent, and in one instance hemorrhagic exudation. His observations were based on post-mortem examinations in nine cases, as follows: three cases of tuberculous meningitis, one case of purulent meningitis consecutive to an acute otitis media, two cases of cerebro-spinal meningitis, and three cases of cerebral tumor.

As to treatment, Pitt says that it does not seem probable that surgical interference, when meningitis has once thoroughly developed, will be of any use; but it is clear that at an earlier stage the lesions which precede the meningitis in almost all cases are such as are capable of treatment by free drainage, which may sometimes be successful. A fatal termination may more frequently be averted “when it is recognized that it is desirable to operate sooner than we have hitherto done in those cases of ear-disease in which there are severe local symptoms.”

General Conclusions.—From a study of the investigations of Pitt, Barker, and others we learn that cerebral abscesses occur rather less frequently than meningitis or sinus-thrombosis. In two-thirds of the cases the abscesses occur close to the tegmen tympani; when found elsewhere, there is

¹ J. O. Green, M.D., Boston Medical and Surgical Journal, June 19, 1890.

² International Congress, Otolology and Laryngology, Paris, September, 1889.

generally discovered a thrombosis or some other complication. An agonizing headache usually indicates cerebral abscess; rigors, thrombosis of a sinus; and fever, either thrombosis or meningitis.

Optic neuritis is most frequently found with thrombosis of a lateral sinus. Recent otitis media may set up a meningitis; abscess occurs only in chronic cases. The more insidious the onset the greater the probability that the complication is a cerebral abscess. Abscess and sinus-thrombosis, with their associated diseased dura mater, are frequently unaccompanied by other lesions. Surgical interference, therefore, offers some hope of success if undertaken early. Meningitis is secondary to other lesions, and is beyond treatment unless it is very circumscribed.

Mr. Barker's conclusions, based on temperature lines, may be briefly stated as follows:

In *pyæmia (sinus-thrombosis)* the temperature lines are of extreme irregularity and the oscillations frequent.

In *meningitis* the temperature lines are not so irregular as in pyæmia, but are often persistently higher.

In *subdural abscess* the fever is high and steady if the case is uncomplicated, which is not common.

In *cerebral abscess* the temperature lines are unusually low, often sub-normal, and do not show much oscillation.

PYÆMIA AND METASTATIC PROCESSES.

Chronic suppuration, after destroying the osseous canal, the tegmen tympani, and the mastoid portion, but without attacking the brain-cavity, may lead to pyæmia and abscess in the lungs,¹ or, in consequence of chronic aural purulency, an abscess may form in the neck and at the same time a destructive purulent irido-choroiditis may occur.² Purulent infection from suppuration of the middle ear, in the form of pleuro-pneumonia, has been observed;³ also embolic abscesses in the lungs, kidneys, liver, and spleen in the same subject; a cold abscess under the clavicle in another; periostitis about a previous healthy molar tooth in another.⁴ The same observer records cases of embolism in the various joints, the omentum, the bladder, and the various glands, from chronic suppuration in the middle ear. Some of these latter lesions were in connection with abscess in the brain, which seems to point to the embolic origin of most, if not all, brain-abscesses.

The author has observed embolism of the lung and liver in a case of chronic purulent otitis media with mastoid symptoms, in which the brain and meninges were entirely healthy.

¹ Dr. H. N. Spencer, Transactions of the Medical Society of Missouri, April 21, 1875.

² Dr. O. D. Pomeroy, Transactions of the American Otological Society, 1888.

³ Dr. Roosa, Transactions of the American Otological Society.

⁴ Dr. Szenes, Deutsches Archiv für Klinische Medicin, December 24, 1888.

MALIGNANT DISEASE.

Malignant disease of the ear, in consequence of chronic purulent otitis media, shows itself generally in one of two forms,—viz., carcinoma and sarcoma. *Carcinoma* is developed from the epithelium of the external auditory canal or from that of the drum-cavity. At first it may not be recognized in its true guise, but may be regarded as an ordinary chronic otorrhœa. Soon, however, the paroxysmal pain, the blood-stained discharge, and the formation of a mass of granulations which bleed copiously when touched even lightly, should lead to the suspicion of the presence of a malignant growth in the ear. If these granulations are removed, others quickly grow again, and the discharge becomes more copious and fetid. The microscope will now throw light on the nature of the disease in the ear. Increase in the size of the growth may be followed by paralysis of the facial, acoustic, and other nerves near the temporal bone. The mastoid is usually attacked, and openings occur in it and in front of the auricle. The maxillary and both occipital joints may be destroyed. Instead of these outward manifestations of disease, symptoms of intra-cranial lesions only may be found. The disease attacks persons between forty and sixty years of age, and generally lasts a year and a half.

Sarcoma is generally developed from the dura mater or the periosteum of the mastoid; also from the periosteum of the external auditory canal and middle ear. There are discharges from the ear, and numerous bleeding granulations, with pain. The tissues about the ear swell quickly and greatly, and death occurs in from three to six months. Sarcoma attacks children in preference.¹

Harlan² has recorded a case of bloody, purulent, offensive discharge from the ear of a child three years old. For two months before death there were polypoid growths in the ear, with paralysis of the facial, the sixth, and the ophthalmic branch of the fifth nerve. After death it was found that the growth in the auditory canal was a round-cell sarcoma. Round-cell sarcoma of the ear, following chronic suppuration, has also been reported by Dr. J. O. Green.³ Chronic suppuration of the middle ear, with epithelial tumor extending upward into the cranial cavity, with extensive necrosis of the mastoid and other portions of the temporal bone, without external swelling,⁴ and epithelioma⁵ of the middle ear from chronic suppuration and consequent local irritation, have also been observed. Carmalt⁶ gives an account of a case of chronic suppuration in the ear of a man forty-seven years old, in whom the disease had lasted forty-two years, after

¹ See article by Kretschmann on "Fatal Ear-Diseases," Berlin, 1890.

² Philadelphia Medical News, December 13, 1873.

³ Archives of Otology, vol. xiii. No. 2, 1884.

⁴ Mathewson, Transactions of the American Otological Society, vol. ii. p. 270.

⁵ Kipp, Transactions of the American Otological Society, vol. ii. p. 484.

⁶ Transactions of the American Otological Society, 1880.

measles. There had been no serious symptoms all this time until a few weeks before death, when there was sudden pain in and about the ear, with very offensive discharge, ragged excrescences from the auditory canal, facial paralysis, and blocking of the entire middle ear with a carcinomatous mass. Death took place from hemorrhage, due, probably, to erosion of the lateral sinus. Adenoma¹ of the petrous bone and middle ear, carcinoma² of the external ear, with facial paralysis and meningitis, and sarcoma³ of the drum-cavity and mastoid process, resulting from chronic purulent otitis media, have been graphically described by the writers cited.

All these fatal results are due to *neglect* of a purulent discharge from the ear. It is highly probable that all of them could have been prevented by prompt and proper treatment of the ear-disease when it appeared in childhood. Not only would life have been saved, but it would have been rendered happier and better while it lasted.

¹ Sexton, New York Medical Journal, December 13, 1884.

² Ludewig, Archiv für Ohrenheilkunde, Bd. xxix., 1890.

³ Archiv für Ohrenheilkunde, Bd. xxx., May, 1890.

REMOVAL OF THE STAPES IN CHRONIC CATARRHAL AND IN CHRONIC SUPPURATIVE OTITIS MEDIA.

BY FREDERICK L. JACK, M.D.,

Instructor in Otology, Boston Polyclinic; Assistant Surgeon, Massachusetts Charitable Eye and Ear Infirmary, etc., Boston, Massachusetts.

THE removal of the stapes for the relief of deafness is an operation of very recent origin. Advances in aural surgery in the last few years have been gradually leading up to this step, and now this last advance opens up a new field and seems to offer a more encouraging outlook for relief to the deaf than any operation heretofore done.

Experience being limited to a few months, it is not yet possible to make any certain rules. The operation has been done on ears with chronic catarrh and also on cases of chronic suppuration, both active and healed. In the active cases, however, the ossicle was removed only when carious, the object being to heal the ear. Good results may be expected in all cases free from disease of the internal ear, or where long-continued pressure on the fluid of the labyrinth by an impacted stapes has not injured the fibres of the auditory nerve. The operation is a delicate one, and demands of the surgeon patience and steadiness. At times it is difficult, and even impossible, to remove the entire ossicle; yet even in these cases not only has no harm been done, but some improvement in hearing has been noticed.

What is contained in these few pages is necessarily, to a great extent, the account of a personal experience. About twenty-five operations of this kind have been done by the writer, and in the account of these cases is comprised a great part of what is practically known about the subject. In a paper read before the American Otological Society, July 20, 1892, the reasons for first doing the operation were stated, and a detailed account of cases was given. This article is largely a repetition of that paper.

HISTORY OF THE OPERATION.

As far back as 1875 the attention of the medical public had been called by Kessel to the removal of the drum-membrane, malleus, and incus, for the purpose of improving the power of hearing. Attention was again called to the same subject in 1885 by Schwartze, who added the result of his own

experience in performing the operation. On July 20, 1886, Dr. Sexton read a paper before the American Otological Society, describing what is practically the same operation as that performed by Drs. Kessel and Schwartze, but with a different object in view. This object was the cure of chronic otorrhœa. Later, he did the same operation to improve hearing.

The circumstances which led to the removal of the stapes were these. Last spring, at the Massachusetts Charitable Eye and Ear Infirmary, the operation for the relief of otorrhœa described by Dr. Sexton was performed many times with general success.

CASE A.—About June 19, 1892, the writer undertook the operation on I. D., aged twelve, whose ear had been discharging constantly since babyhood, the result of an attack of scarlet fever. Having removed portions of the membrana tympani, malleus, and incus, and curetted a few granulations from the attic, an examination with the probe showed the head of the stapes to be carious. Fearing the operation would not be successful if the stapes, in such a condition, were left in the ear, it was determined to remove it. By passing a slender knife around the head of the bone, it was loosened from its adhesions; after this a very small hook was introduced behind it, and it was extracted with little effort. However, in its removal, there was observed an amount of suction which led to the fear that a portion of the bony wall might have adhered to it. But this fear proved ungrounded. The removal of the stapes was undertaken in this case with the greater hope of success, as there was in mind an article recently published by a Spaniard,¹ in which it was stated that the stapes had been removed accidentally by him from a man's ear and that the hearing had been improved, and experimentally from animals without apparent injury. Careful tests made before the operation on I. D. had shown that there was very little hearing in the ear, as will appear later by the report of the case. On the morning following the operation the patient said that she now heard sounds which she had never before noticed. This fact struck the writer so forcibly that he was led to hope for good results from the removal of the stapes in other cases.

Some weeks previous to this, two cases of chronic non-suppurative inflammation of the middle ear, from which had resulted a marked degree of deafness, were operated upon in order, if possible, to improve the hearing. From the ears in the worse condition the entire drum-membrane, malleus, and incus were removed. The history of these cases is as follows.

CASE B.—B. S., thirty-five years old, had been hard of hearing for fifteen years, but had grown rapidly worse within the last two years. Loud voice heard at a few feet. Both drum-heads were dull in color and slightly sunken. Operation, April 2, 1892. Left membrana tympani, malleus, and incus removed. Operation was followed in a few days by pain and slight mucous discharge. No improvement in hearing. Two months after the operation, the ear remaining without treatment during the time, granulations

¹ Ricardo Botey, of Barcelona, *Expériences d'Avulsion de l'Étrier chez les Animaux*, *Annales des Maladies de l'Oreille*, No. 1, January, 1891.

were discovered on the promontory. These were partially removed, touched with a solution of copper, and dermatol insufflated. At the present time the ear is healed, but the hearing remains the same as before the operation.

CASE C.—D. S., fifty years old. Hearing much impaired for eight years by chronic non-suppurative inflammation of the middle ears. The drum-heads were thickened and retracted. May 18, 1892, operation on the right ear the same as in the preceding case. The hearing was improved for several days, and then gradually returned to the previous condition. Patient experienced considerable pain for two nights, and was annoyed for four weeks by a purulent discharge from the ear, which up to the present time continues to form crusts.

Notwithstanding the fact that these operations were performed with all care, and that there was in the second case an improvement in the hearing for a few days, both cases subsequently developed otorrhœa, and the second, tinnitus. Furthermore, in the second case the drum-membrane had been entirely reproduced, with the exception of an extremely small opening in the centre. Led by the results in these three cases, it was resolved in future to see what would be the effect of removing but a small portion of the drum-membrane and the stapes only, leaving the malleus and incus; since which time the writer has performed operations in this way, with uniformly good results. Recently, the benefits to be derived from the removal of the stapes were suggested to the last two patients above mentioned, with the hope of thus securing what would be, perhaps, the very best basis of comparison of the two operations. Unfortunately, they declined to submit to further surgical treatment.

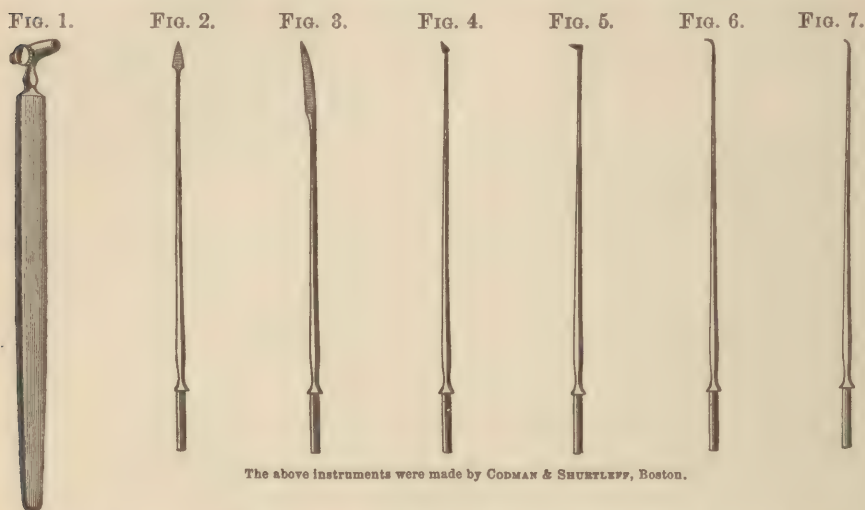
DESCRIPTION OF THE OPERATION.

The patient is thoroughly anæsthetized in the upright position and the head held perfectly still by an assistant. The small field of operation is clearly illuminated by an incandescent electric head-light, or by reflected daylight, which is usually sufficient. Absolute cleanliness is to be observed. Each step in the operation must be slowly and most thoroughly performed, and it may be necessary sometimes to use a magnifying glass.

The instruments required for the operation consist of three adjustable handles (Fig. 1) into which all the instruments fit; two paracentesis knives (Fig. 2), one small knife to be used around the head of the stapes; knife for cutting stapedius muscle (Fig. 3); four knives with points at various angles (Figs. 4 and 5); hooks of different lengths (Figs. 6 and 7); forceps (Fig. 8); one olive-tipped probe (Fig. 9); right and left incus-hooks with bullet tips (Figs. 10 and 11), and one straight probe with bullet tip (Fig. 12).

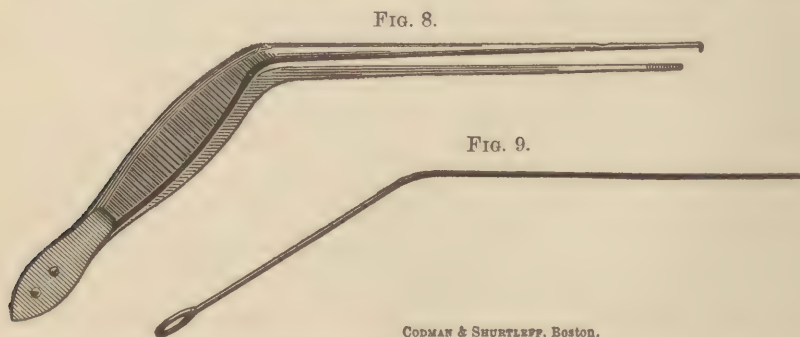
The first step is to make a cut shaped like an inverted V in the drum-membrane just over the incudo-stapedial joint and allow the part so loosened to fall outward, being careful to make the incision very close to the auditory ring. The forward incision is started just behind the handle of the

malleus and carried up to meet the first cut. This gives a clear view of the long process of the incus and the incudo-stapedial articulation, and also affords an excellent opportunity to observe directly the pathological conditions in this, the part of the ear most important for hearing. Sometimes,



as one or two of the following cases illustrate, a condition is found which none of the ordinary tests for hearing could have revealed. It might be well then in certain instances, even for diagnostic purposes alone, to make such an exploratory opening.

It is important next to completely separate the stapedius muscle from the head of the stapes. This is done by passing a very slender knife (Fig. 3) behind the head of the ossicle and then carefully cutting the muscle at a short distance from the neck of the bone. Experience shows that this muscle must be completely severed, otherwise, when the stapes is loosened,

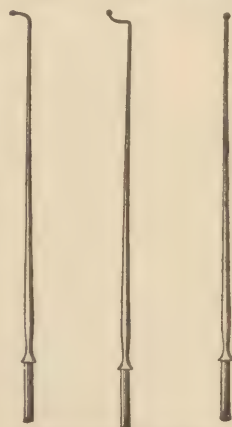


the muscle will pull the head of the bone out of sight and cause great trouble in its subsequent removal. Having cut the muscle, any adhesions between the long process of the incus and inner bony wall of the middle-ear cavity are divided. Often the process so freed will spring downward into

place, facilitating the next step. The articulation with the long process of the incus is then severed by passing a very small triangular knife, bent at an obtuse angle, through the joint, from behind forward. (Fig. 4.) If the stapes is not yet perfectly loose, it can be made so by passing a small pointed knife (Fig. 2) around its head. A small hook (Fig. 6) now introduced behind the head, or sometimes forceps (Fig. 8), will, with gentle traction, usually remove it. However, in a few cases the ossicle will be found so firmly fixed by bony adhesions that a portion will unavoidably remain in the oval window. Yet even in those cases some improvement may be expected. The bonelet usually comes away with some suction.

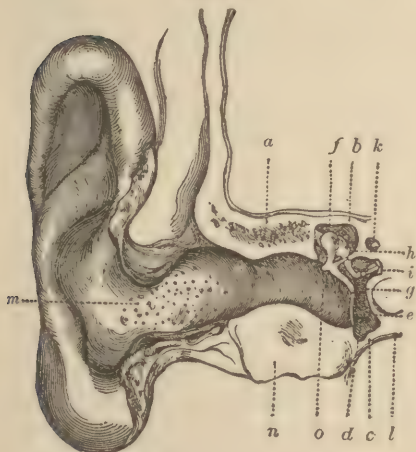
In some cases it may be necessary to remove the incus to make room for removal of the stapes. This occurs especially in those cases in which the topographical relations of the auditory ring, together with marked retraction of the ossicular chain, render the space for manipulation too small.

FIG. 10. FIG. 11. FIG. 12.



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FIG. 13.



VERTICAL SECTION OF THE EXTERNAL MEATUS, MEMBRANA TYMPANI, AND TYMPANIC CAVITY, RIGHT EAR (Politzer).—*a*, upper wall, osseous canal; *b*, roof of the tympanic cavity; *c*, inferior wall; *d*, tympanic cavity; *e*, membrana tympani; *f*, head of the malleus; *g*, handle of the malleus; *h*, incus; *i*, stapes; *k*, Fallopian canal; *l*, jugular fossa; *m*, wax glands; *n*, lower wall, osseous canal; *o*, short process.

This condition of the ear will sometimes render the operation impossible. The few drops of blood that ooze from the wound are easily controlled by applications of a two-per-cent. solution of cocaine. The field of operation must be kept absolutely dry with cotton, as the operator must see what he is doing. Slowing of the pulse on touching the stapes is noticed in some cases. This may arise because the patient is not thoroughly under ether. The patients usually remain quietly in bed two or three days, keeping the ear plugged with a collodion dressing undisturbed. A clot of blood remains in the wound for a few days, but gradually disappears. Experience has shown that in the cases where the ear has suppurated the operation is rendered much more difficult by the conditions thus pro-

duced than in cases of so-called chronic catarrh.

PATHOLOGY.¹

The pathological changes which may render operative interference advisable for the mobilization of the ossicular chain are, for the most part, of a general character affecting the contents of the tympanum, except contractions of the tympanic muscles. These general pathological conditions involve the connective tissue more commonly and the bone occasionally. In the connective tissue the changes are a contraction and consequent rigidity following upon hyperplasia of the tissue, with or without the deposition of lime salts, as a result of an inflammatory process. The character of these inflammations varies between two extremes,—the extremely indolent, so-called sclerosis, and the more active suppurative, resulting in cicatrization. In sclerosis, which is probably due to chronic hyperæmia causing cellular infiltration, the tissue becomes thinner and more rigid than normal, often with deposits of lime salts about the ligaments of the ossicular joint-apparatus and the orbicular ligament of the stapes. In the suppurative form the amount of tissue is often much increased, embedding the ossicles in cicatrices.

The changes in the bone impeding the movements of the ossicles are exostosis and hyperostosis, more rarely synostosis. For causation, syphilis is probably a more important factor in this group than in the preceding.

Owing to the anatomical relations of the stapes, it is the ossicle which most readily has its motion impeded by pathological changes. Its position at the bottom of the oval pelvis renders it easily affected by the tightening of the bands and folds of mucous membrane which normally pass between it and the bony wall, or by exostosis of the foot-plate and surrounding parts which sometimes results in ankylosis.

CASES.

CASE I.—I. D., aged twelve. Otitis media suppurativa chronica in left ear for eight years. Heard only moderately loud voice. Ear continually discharging. The upper portion only of the drum-membrane was left.

Operation, June 3, 1892.—Remnant of drum-membrane with the malleus and incus removed. Small amount of granulations curetted from the attic. Head of stapes found carious. It was separated from adhesions and removed with the hook. Slowing of the pulse was noticed upon moving the ossicle. Soon after the operation, slight dizziness. No pain in the ear. Could now hear voices better than before. Ear ceased discharging in two days. Nineteen days after the operation the middle ear was found perfectly dry.

Five weeks after the operation the ear was found still perfectly dry, and a moderately loud voice could be heard at twenty-five feet.

¹ I am indebted to Dr. William S. Bryant, of the Harvard Medical School, for these notes.

CASE II.—A boy, twelve years of age, in poor physical condition. Chronic suppurative inflammation in the right ear for several years. A small portion only of the membrana tympani was left, and the manubrium of the malleus had sloughed away. He could distinguish words spoken in an ordinary voice at ten feet.

Operation, June 6, 1892.—The remains of the membrane and the malleus were removed with some difficulty because of thick bands of tissue around the head of the bone. The incus was found, after long searching, firmly adherent to the anterior superior portion of the attic. It was freed from its attachment by means of a slender curved knife and removed with a bullet-tipped incus-hook. The head of the stapes was next loosened and the bone removed. Nothing peculiar was noticed about the pulse. The ear was syringed with a solution of corrosive sublimate (one to three thousand) and sealed with absorbent cotton. The operation lasted one hour and fifteen minutes. For the next twenty-four hours the patient had considerable vertigo. He said that, on moving his head on the pillow, objects in the ward went "round and round."

July 8, 1892.—Hearing had improved since the operation. Could hear whispered voice 8 feet, ordinary voice 18 feet. Ear only slightly moist, and it had not been syringed for one month.

CASE III.—A boy, about twelve years old, with chronic suppurative inflammation in the left middle ear for nine months. A small perforation was discovered high up in the membrana flaccida, but the membrana tensa was whole.

Whispered voice, 18 inches; ordinary voice, 20 feet; H. A. S., $\frac{4}{60}$; tuning-fork, R. C. vertex, S. plus; mastoid, S. plus.

Operation, June 18, 1892.—The entire membrana was separated from the auditory ring. The tensor tympani was divided and the malleus brought forward by passing a blunt hook behind the neck. The incus was removed without difficulty by means of a hook. The head of the stapes was next loosened and removed by means of hook and forceps. The bone came away in three pieces, leaving in the window a small portion of the foot-plate. The attic was found crowded with granulations, a condition which was suspected before the operation. These were carefully removed with forceps and curette. Three weeks afterwards the ear was discharging slightly and the hearing was as follows:

Whispered voice, 8 feet; ordinary voice, 20 feet; tuning-fork, bone, S. plus; mastoid, S. plus; H. A. S., $\frac{2}{60}$.

CASE IV.—A woman. Anæmic and worn out with pain from syphilitic iritis. The left middle ear showed the effects of an old suppurative process. Through a thin cicatrix the long process of the incus and the head of the stapes were seen.

Loud voice heard at 15 feet; H. A. S., $\frac{3}{60}$; König's rods, 35,000; tuning-fork by bone in left ear.

A triangular opening was made through the cicatrix. The tendon of

the stapedius muscle was cut, the incudo-stapedial joint divided, and the head of the stapes freed from synechial bands. The bone was now quite movable, but eluded all attempts to engage the hook behind the head. It was, however, at last captured and removed entire. The trouble experienced here was undoubtedly due to the action of the stapedius muscle, which was not wholly divided. The bone being loosely held in the oval window, the action of the muscle naturally pulled the head out of sight. No change in the pulse was noticed. There was no bleeding. Nausea and vertigo were complained of for twenty-four hours. She was somewhat dizzy in walking for six days. Hearing much improved. H., $\frac{10}{60}$; whispered voice, 8 feet; ordinary voice, 20 feet; improvement in König's rods of 5000.

Ear showed no signs of inflammation at the end of a week. Sixteen days after the operation the hearing remained good.

CASE V.—A man, about forty years old. He gave a history of having had chronic suppurative inflammation of the right middle ear for twenty-five years. He had been very hard of hearing in the ear ever since that time, and said he considered it "dead." Complained of a disagreeable pressure on that side of the head. Examination of the ear showed extensive destruction of the membrana tympani. Malleus retracted and firmly adherent to the inner wall of the middle ear. The long process of the incus was not visible. Head of the stapes covered with a thick cicatricial membrane. Hearing very defective.

For H., $\frac{0}{60}$, contact; whispered voice not heard; ordinary voice, 1 foot; König's rods, 35,000; tuning-fork by air, 5'', bone, D. plus.

Operation, June 20, 1892.—A triangular opening was made in the membrane over the stapes. A very slender knife was carried around the head of the stapes and the tendon of the stapedius muscle divided. Owing to the prominence of the head, it was grasped with small forceps and all but about one-half of the foot-plate was removed. This piece remained in the fenestra and was easily felt afterwards with a probe. This being the state of affairs, it was a surprise on the morning after the operation to find a marked improvement in all but one of the tests of hearing previously tried.

H., $\frac{1}{60}$; loud whisper, 2 feet; ordinary voice, 9 feet; loud voice, 20 feet; König's rods, 30,000, a loss of 5000.

Four days after returning home his hearing remained the same and the pressure previously complained of in the head had disappeared. He volunteered the story that before the operation his wife had complained very much of the squeaking made by a pair of new slippers. He failed to hear the noise at that time, but on his return home he also found them too noisy.

July 8, 1892.—Said he had thrown the new slippers away. Hearing remained good and practically the same as when last tested. The ear was perfectly healed. The membrana tympani had somewhat contracted from the fenestra ovalis and was adherent to the inner bony wall of the middle

ear. The anterior segment of the membrane was somewhat more sunken than when seen shortly after operation. This condition made no apparent difference in the power of hearing, and did not tend to produce the pressure in the head complained of before.

CASE VI.—A woman, twenty years of age. Deafness due to the effects of a chronic suppurative inflammation. No discharge from either ear for two years. Said she could not hear anything in the left ear. Everything had ulcerated away except the stapes, the head of which was made out through a somewhat thick cicatrix. Hearing in the left ear as follows:

Whispered voice, not heard; ordinary voice, not heard; loud voice, 1 foot; H. A. S., $\frac{9}{60}$; tuning-fork, by air, not heard; by bone, in the better-hearing ear.

Operation, June 11, 1892.—Head of stapes loosened and stapedius muscle divided. A hook readily brought away the bone.

June 20, 1892.—No pain or vertigo; hearing greatly improved.

Whispered voice, 1 foot; ordinary voice, 15 feet; loud voice, 20 plus; tuning-fork, air, 2''; bone, still heard in better-hearing ear; H. A. S., $\frac{1}{60}$.

One month after the operation hearing remained as when last tested. Ear perfectly dry, with no crusts. Said she could now carry on her work of stenography without trouble.

CASE VII.—A boy, eighteen years of age. Patient was first seen on June 19, for deafness in the right ear. Upon examination the right drum-membrane was found partially destroyed and the remaining portion was calcified. Thick tissue over the fenestra ovalis. Ear had ceased discharging some years ago, and the hearing had been gradually growing worse.

Hearing, H., $\frac{6}{60}$; König's rods, 35,000; ordinary voice, 9 feet; tuning-fork, R. plus by bone.

Operation, June 20, 1892.—Head of stapes found with difficulty after cutting almost calcareous bands of tissue. The bone was very firmly held in place. Crura were found so firmly fixed in the window that only portions could be removed. The head of the bone came away readily. The pulse was noticed to be slower upon moving the stapes.

June 21, 1892.—No pain complained of. Hearing much improved. Tests as follows:

H. A. D., $\frac{8}{60}$; König's rods, 40,000; whispered voice, 4 feet; ordinary voice, 30 feet plus.

Only slight redness observed at seat of operation.

CASE VIII.—A girl, seventeen years of age. Deafness in the right ear due to the effect of a chronic suppurative inflammation. A large perforation was found in the posterior half of the membrana tympani, through which the head of the stapes was distinctly seen. Complained of a buzzing tinnitus.

Hearing for whispered voice, 4 feet; ordinary voice, 20 feet; H. A. D., $\frac{5}{12}$; König's rods, 35,000.

Operation, June 21, 1892.—The head of the bone was thoroughly sep-

arated from adhesions and easily removed by means of a small hook inserted behind the head. No bleeding. Pulse was perceptibly slower while moving the stapes. June 22, no symptoms.

Hearing, H., $\frac{12}{60}$; loud whisper, 15 feet; ordinary voice, 25 feet plus; König's rods, 30,000.

Seventeen days after the operation ear was perfectly healed. Less tinnitus. Hearing the same as when last tested, except for the watch. Here there was apparently a loss of ten inches.

Improvement in hearing noticed by members of her family and friends.

CASE IX.—A man, thirty-five years old. Deafness in the left ear since boyhood, the effects of a chronic suppurative inflammation following an attack of scarlet fever. A large perforation was found in the posterior upper quadrant of the drum-membrane. Head of the stapes easily seen and removed in the manner previously described. Hearing before the operation,—

H., $\frac{1}{60}$; whispered voice not heard; ordinary voice, 2 feet; loud voice, 12 feet.

On the morning after the operation the patient complained of slight dizziness when sitting up in bed. Hearing for the voice improved.

June 27, no dizziness. Hearing better than immediately after the operation; no signs of inflammatory reaction in the ear. Can now hear:

Whispered voice, 1 foot; ordinary voice, 25 feet plus; tuning-fork by bone, D. plus; tuning-fork, air, 35''; H., $\frac{6}{60}$; König's rods, 30,000.

He was last seen nine days after the operation, and was found to hear as well as when previously tested.

CASE X.—J. M., nineteen years old. She had been troubled with chronic suppurative inflammation off and on for fifteen years, and had had trouble in hearing for two years. The posterior segment of the membrana tympani had ulcerated away. The round window and the long process of the incus were easily seen.

Hearing for H., $\frac{4}{60}$; whispered voice, 2 feet; ordinary voice, 6 feet; tuning-fork, bone, D. plus; König's rods, 30,000.

Operation, June 22, 1892.—Stapedius muscle was first cut, and then the incudo-stapedial joint. Some trouble was experienced in removing the stapes from behind the long process of the incus. The incus was found so loose that, in passing a hook above the head to remove it, it fell from its position to the bottom of the middle ear behind the drum-membrane and could not be removed with any instrument at hand. It was finally removed by syringing. On the following day she complained of some dizziness. Hearing better, except for watch, which could not be heard on contact.

Whispered voice, 3 feet; ordinary voice, 9 feet; loud voice, 25 feet; tuning-fork, vertex, S. plus, T., D. plus.

July 1, slight dizziness; hearing the same; slight moisture in the ear. In two weeks the wound was found perfectly healed. Hearing remained good.

CASE XI.—A woman, thirty-five years of age. This case is one of the most interesting in the series. She gave a history of sudden loss of hearing in the left ear six months before, accompanied with tinnitus and vertigo. Membrana tympani somewhat thickened. The hearing of this ear was very carefully tested by the writer and others, and found to be absolutely gone for all sounds, except a very loud shout through a conversation-tube. Tuning-fork by bone heard only through the right ear. The operation for removal of the stapes was performed on the morning of June 23, 1892. In the evening, much to our surprise, she could hear the voice in the ear, but the hearing was not carefully tested until the next morning, when it was found as follows:

H. A. S., $\frac{6}{60}$, lightly; whispered voice, 7 feet; ordinary voice, 10 feet; loud voice, 20 feet; tuning-fork, vertex and T., S. plus; air, T., 15''; König's rods, 45,000.

The patient was tested by the same gentlemen that saw her before the operation, with results practically agreeing. She was entirely free from dizziness and tinnitus.

July 8, fifteen days after the operation, the hearing remained good. Tuning-fork by bone now heard louder in the ear which was operated upon. Has had no attacks of dizziness and tinnitus. Wound perfectly healed.

CASE XII.—F. D., twenty years old. For some years her hearing, in spite of treatment for the nose as well as the ears, had been growing slowly worse. It was the result of chronic non-suppurative inflammation of both middle ears. The left was the worse,—ringing tinnitus at times in the left ear. No history of otorrhœa, but a small cicatrix was observed directly over the head of the stapes on the left side. Her hearing in the right ear was fair, and in the left ear as follows:

Ordinary voice, about 1 foot; loud voice, 4 feet; H. A. S., $\frac{2}{60}$; tuning-fork, air, 15'', through teeth in left ear; König's rods, 30,000.

Operation, June 26, 1892.—Triangular cut through the cicatrix and head of stapes separated from all attachments and the bone removed in one piece from the fenestra ovalis. No change in the pulse-rate was noticed.

June 28, complained of slight pain in the ear. Seat of operation covered with a dry clot of blood. Was somewhat dizzy on moving the head quickly. Temperature night before one degree higher than normal. Said she had noticed a great improvement in hearing. It was found to be as follows:

Low whispered voice, 1 foot; ordinary voice, 10 feet; loud voice, 18 feet plus.

Tuning-fork by bone heard louder in right ear; just the reverse was found before the operation; H. heard only on contact; König's rods, 30,000.

July 10, two weeks after the operation. Dry clot of blood covering seat of wound. A little tinnitus at times. Said that hearing had improved greatly since the operation. On returning home, could hear sounds of teams

on the road much better than she had ever heard them before. Friends and relatives all noticed great change.

H., $\frac{6}{60}$; tuning-fork, air, 50''; bone, S. plus; whispered voice, 18 feet.

The patient returned to the Infirmary in September, of her own accord, and asked for the operation on the right ear. This was done September 27, 1892. The results in this case show conclusively the great value of the procedure, as follows:

Before Operation.		After Operation.	
Whispered voice	6 inches.	Whispered voice	6 feet.
Moderate voice	10 feet.	Moderate voice	30 feet.
Watch	$\frac{6}{60}$.	Watch	$\frac{6}{60}$.

The peculiar value of this case as evidence lies in the fact that there is no stapes in either ear. In each instance immediate great improvement followed the removal. Further, the conditions in the two ears were different, the left having had a suppurative inflammation and the right a chronic catarrh.

CASE XIII.—A. C., sixteen years old. Increasing deafness for two years. Worse in left ear. Diagnosis, otitis media insidiosa (sclerosis).

H. A. S., $\frac{6}{60}$, lightly; tuning-fork, air, D. plus; vertex and T., S. plus; König's rods, 35,000; whispered voice, 2 feet; ordinary voice, 4 feet; loud voice, 10 feet.

Left drum-head quite transparent. Long process of incus made out with difficulty.

Operation, June 27, 1892.—Triangular opening made through the drum-membrane. Long process of incus found firmly adherent to inner wall. On being released by introducing a bent knife behind the process, it sprang outward and backward, probably by the action of the stapedius muscle, which, as we shall see, was a powerful one. The operation might have stopped here and been followed by marked improvement in hearing. The stapedius muscle was next separated, as was supposed, and the articulation with the incus divided. A small hook brought the stapes from the oval window, when the stapedius muscle immediately pulled it out of sight. This accident occasioned no end of trouble, and portions of the bone were left in the ear as less likely to cause subsequent trouble than further manipulations. A little dizziness was experienced after the operation, but for a few hours only. A slight exudation was noticed for a few days. The hearing was greatly improved.

July 5, eight days after the operation, the hearing was as follows:

Whispered voice, 5 feet; ordinary voice, 15 feet; tuning-fork, bone, S. plus; H., $\frac{2}{60}$; König's rods, 50,000.

CASE XIV.—A lady, forty-five years old. She had been very deaf for twenty years, the result of otitis media insidiosa (sclerosis). The membrana tympani looked fairly well, though somewhat dull in color.

Whispered voice not heard; ordinary voice, 6 inches; loud voice, 5 feet;

ordinary voice, only 5 feet through large ear-trumpet; tuning-fork by bone in air, in the right; watch not heard in close contact; König's rods, 20,000.

Operation, June 28, 1892.—Small triangular opening made in the drum-membrane. Stapedius muscle was first divided, and then the incudo-stapedial joint. A few adhesions were also separated from the head of the bone. The stapes was removed in the usual way. Examination showed the absence of foot-plate. No attempt was made, however, to remove it, for a case already reported was in mind, where, with a portion of the foot-plate remaining, marked improvement in hearing resulted. Patient was up and dressed the next morning, having experienced no dizziness or pain. Hearing considerably improved.

Whispered voice, 1 foot; ordinary voice, 7 feet; loud voice, 20 feet; tuning-fork, vertex, S. plus; teeth, D. plus; König's rods, 40,000; H., $\frac{0}{00}$ contact.

Said she could hear voices much clearer than before. No sign of inflammation in the ear. Nine days after the operation the hearing was found the same as when last tested, except for tuning-fork and rods. Tuning-fork by bone was now heard alike in both ears. König's rods only 30,000. Ear perfectly dry.

CASE XV.—A woman. Effects of suppurative inflammation. In this case the stapes was not found. What was supposed to be the long process of the incus proved to be the displaced handle of the malleus. The end was somewhat bifurcated. The bone was freed from its attachments and removed, after which careful search with the probe failed to discover any trace of the incus or stapes. Slight dizziness was complained of for twenty-four hours.

Nine days after the operation, by careful tests, the hearing was found improved six inches for watch and a few feet for the ordinary voice. This slight improvement was probably due to the loosening of the tissues about the oval window. Slight discharge from the ear, but less than three days before.

CASE XVI.—Miss K. M., aged forty-seven. She had been gradually growing deaf for five years, the result of a progressive non-suppurative inflammation of both middle ears. Both drum-membranes were somewhat thin and lacked lustre. The incudo-stapedial joint seen in both ears.

In the right ear she heard loud voice only at 3 feet, watch not heard at all; tuning-fork, air, about 3'', bone, D. plus; König's rods, 30,000.

The usual operation was performed on June 30, 1892. After removing the stapes the incus seemed to drop down from the attic, and, being very loose, was removed. On the next day hearing for voice had wonderfully improved.

Whispered voice, 6 feet; ordinary voice, 19 feet; loud voice, 30 feet; tuning-fork by bone heard equally well in both ears; by air in the right, 10''; H. D., $\frac{0}{00}$ contact; König's rods, 35,000.

No inflammatory reaction in the ear. Said she was made dizzy by lying

on the right side. In a week the dizziness had disappeared, and hearing for the voice seemed to have improved still more.

Many of these cases have been seen since writing the report. The hearing-power in all is as good as when reported, and in some a still further improvement has been noticed. Equally good results have been obtained in other cases.

While recognizing the possibility of error in everything, the results obtained in these cases are of such a nature as to lead one to be very hopeful of the future possibilities of the operation. Any fear of danger connected with it is obviated by the fact that even in two of the above-mentioned cases, where there was considerable suppuration at the time of operating, there were absolutely no bad results, but, on the contrary, one of the ears healed entirely within four or five days and the other was greatly improved. In a few cases the patients complained of vertigo, which, however, entirely disappeared within four or five days. In general, the cases showed very little tendency towards inflammatory reaction, and the ears were, after a few days, entirely dry.

The results obtained are strangely at variance with the statements of Buck in his "Manual of Diseases of the Ear." "When the stapes goes, or rather when its foot-plate goes, the hearing-power also vanishes." However, he cites one case as an exception to what he says must be the rule. He further states that it is the only instance he has met with "in which the evidence was fairly conclusive that the expulsion of this most important ossicle had not wholly deprived the patient of the hearing-power in the ear thus maimed."

The effect of the operation on the hearing, as tested by the watch, was not marked in either way in a few cases, indicating in some a slight gain, in others a slight loss. No attempt is made to explain this, but the peculiarity, if sought for, is frequently observed in deaf people. The tests by König's rods met with a similar result.

In one of the above cases a curious fact was brought to light. During the bone test with the tuning-fork before the operation the patient entirely failed to hear it in the worse ear, but on a repetition of the test after the operation she heard it better in the ear operated on than in the other.

Many of the cases were tested both before and after the operation by others than the writer, with nearly corresponding results.

There still remains to be mentioned the one result of this operation which gives it its importance, and that is the very marked improvement in hearing the human voice which is thereby obtained. If persons who have heretofore heard only with difficulty can be made to hear with ease, by treatment unattended with danger, the operation, as above described, which has accomplished this result is certainly worth consideration. As to the reason why this effect is produced, I have no theory to offer other than the simple supposition that it is by the removal of a mechanical obstruction to the sound-waves.

TABULAR VIEW.

(Tests of hearing before and after the operation.)

CASE I.

BEFORE.		AFTER.	
Moderately loud voice	1 foot.	Moderately loud voice	25 feet.

CASE II.

Ordinary voice	10 feet.	Whispered voice	8 feet.
		Ordinary voice	18 feet.

CASE III.

Whispered voice	18 inches.	Whispered voice	8 feet.
Ordinary voice	20 feet.	Ordinary voice	20 feet.
Watch	A. S. $\frac{4}{60}$.	Watch	A. S. $\frac{2}{60}$.
Tuning-fork, vertex	S. plus.	Tuning-fork, vertex	S. plus.
Mastoid	S. plus.	Mastoid	S. plus.

CASE IV.

Loud voice	15 feet.	Whispered voice	8 feet.
Watch	A. S. $\frac{2}{60}$.	Ordinary voice	20 feet.
Tuning-fork by bone in left ear.		Watch	A. S. $\frac{1}{60}$.
König's rods	35,000.	Tuning-fork by bone, left.	
		König's rods	40,000.

CASE V.

Whispered voice not heard.		Whispered voice	2 feet.
Ordinary voice	1 foot.	Ordinary voice	9 feet.
Watch	A. D. $\frac{0}{60}$ contact.	Loud voice	20 feet.
Tuning-fork by air	5 seconds.	Watch	A. D. $\frac{1}{60}$.
By bone	D. plus.	König's rods	30,000.
König's rods	35,000.		

CASE VI.

Whispered voice not heard.		Whispered voice	1 foot.
Ordinary voice not heard.		Ordinary voice	15 feet.
Loud voice	1 foot.	Loud voice	20 feet plus.
Watch	A. S. $\frac{0}{60}$ contact.	Watch	A. S. $\frac{1}{60}$.
Tuning-fork by air not heard.		Tuning-fork, air	2 seconds.
By bone, in the better-hearing ear.		By bone, still in better-hearing ear.	

CASE VII.

Ordinary voice	9 feet.	Whispered voice	4 feet.
Watch	A. D. $\frac{0}{60}$ contact.	Ordinary voice	30 feet plus.
Tuning-fork by bone, right ear.		Watch	A. D. $\frac{2}{60}$.
König's rods	35,000.	König's rods	40,000.

CASE VIII.

Whispered voice	4 feet.	Whispered voice	15 feet.
Ordinary voice	20 feet.	Ordinary voice	25 feet plus.
Watch	A. D. $\frac{2}{60}$.	Watch	A. D. $\frac{1}{60}$.
König's rods	35,000.	König's rods	30,000.

CASE IX.

Whispered voice not heard.		Whispered voice	1 foot.
Ordinary voice	2 feet.	Ordinary voice	25 feet plus.
Loud voice	12 feet.	Watch	A. S. $\frac{0}{60}$ contact.
Watch	A. S. $\frac{1}{60}$.	Tuning-fork, air	85 seconds.
		By bone	D. plus.
		König's rods	30,000.

BEFORE.		CASE X.	AFTER.	
Whispered voice	2 feet.	Whispered voice	3 feet.	
Ordinary voice	6 feet.	Ordinary voice	9 feet.	
Watch	A. S. $\frac{4}{80}$.	Loud voice	25 feet plus.	
Tuning-fork	D. plus.	Watch	A. S. $\frac{c}{80}$ contact.	
König's rods	30,000.	Tuning-fork	S. plus.	

CASE XI.

Hearing absolutely gone for all sounds, except for very loud voice through a conversation-tube.

Whispered voice	7 feet.
Ordinary voice	10 feet.
Loud voice	20 feet.
Watch	A. S. $\frac{c}{80}$ lightly.
Tuning-fork, air	15 seconds.
By bone	S. plus.
König's rods	35,000.

CASE XII.

Left Ear.

Ordinary voice	1 foot.	Loud whisper	10 feet.
Loud voice	4 feet.	Ordinary voice	30 feet.
Watch	A. S. $\frac{2}{80}$.	Watch	$\frac{c}{80}$ contact.
Tuning-fork, air	15 seconds.	Tuning-fork, air	50 seconds.
By bone in left ear.		By bone in left ear.	
König's rods	30,000.	König's rods	30,000.

Right Ear.

Whispered voice	6 inches.	Whispered voice	6 feet.
Moderate voice	10 feet.	Moderate voice	30 feet.
Watch	$\frac{c}{80}$.	Watch	$\frac{c}{80}$.

CASE XIII.

Whispered voice	2 feet.	Whispered voice	5 feet.
Ordinary voice	4 feet.	Ordinary voice	15 feet.
Loud voice	10 feet.	Loud voice	20 feet.
Watch	A. S. $\frac{c}{80}$ lightly.	Watch	A. S. $\frac{2}{80}$.
Tuning-fork by bone	S. plus.	Tuning-fork	S. plus.
König's rods	35,000.	König's rods	50,000.

CASE XIV.

Whispered voice not heard.		Whispered voice	1 foot.
Ordinary voice	6 inches.	Ordinary voice	7 feet.
Loud voice	5 feet.	Loud voice	20 feet.
Ordinary voice, only 5 feet through ear-trumpet.		Watch	A. D. $\frac{0}{80}$ contact.
Watch	A. D. $\frac{0}{80}$ contact.	Tuning-fork, vertex	S. teeth D. plus.
Tuning-fork by bone and air in the right.		König's rods	40,000.
König's rods	20,000.		

CASE XV.

Stapes not found. Slight improvement in hearing.

CASE XVI.

Loud voice	3 feet.	Whispered voice	6 feet.
Watch	A. D. $\frac{0}{80}$ contact.	Ordinary voice	19 feet.
Tuning-fork, air	3 seconds.	Loud voice	30 feet.
By bone	D. plus.	Watch	A. D. $\frac{0}{80}$ contact.
König's rods	30,000.	Tuning-fork, air	10 seconds.
		By bone, alike in both.	
		König's rods	35,000.

ACUTE AND CHRONIC INFLAMMATION OF THE MASTOID PORTION OF THE TEMPORAL BONE.

BY CLARENCE J. BLAKE, M.D.,

Professor of Otology, Medical Department of Harvard University, etc., Boston,
Massachusetts.

OF the various diseases of different portions of the ear, there are none which demand more serious consideration from the aural surgeon than those affecting the mastoid process.

ANATOMY.

A study of the structure of this portion of the temporal bone, and of its relationship both to the middle and the external ear and to other important cavities in its neighborhood, explains the fact that it may readily become a channel for the transmission of morbid processes originating in the middle or the external ear to those more deeply seated and important parts, invasion of which is liable to lead to serious and possibly to fatal consequences. Considered as a whole, and aside from the fact that it is a prolongation virtually of the cavity of the middle ear, and that its lining membrane is continuous with the lining membrane of that cavity, and so affords an area of vascular tissue subject to congestion and inflammation manifoldly greater than that afforded by the middle ear alone, the internal structure of the mastoid cavity itself, in regard to its subdivisions, is such as to render possible considerable differences in the symptoms characterizing an inflammation within its walls; indeed, there is no one bony structure in the human body which presents so many deviations, both in its enclosing walls and in its interior structure, from an arbitrary standard type, as does the mastoid process of the temporal bone, and there is none in which these variations may have so important a bearing upon the welfare of the individual in the event of the cavity's becoming the seat of a morbid process.

The outer surface of the mastoid, for instance, may in its contour be flattened or rounded (Fig. 1); it may be bounded inferiorly by a well-marked digastric fossa, or may merge its outline with only a shallow depression into the surface of the posterior articulating portion of the temporal bone (Fig. 2). On its anterior surface it may either boldly define the posterior wall of the external auditory canal or may trend towards it in

a gradual incline at an angle of forty-five degrees from the median vertical line of the mastoid protuberance. In like measure the thickness of the

FIG. 1.



Large mastoid.

FIG. 2.



Small mastoid.

bony wall is subject to very considerable variations both as to degree and location. The outer wall may be as thin as ordinary writing-paper or so thick as to occupy one-third of the horizontal depth of the cavity (Fig. 3), and it may be firm and compact or permeated by numerous small openings for the passage of vessels (Fig. 4), while the region of the tip of the mastoid and of the digastric fossa may present many variations in thickness within a very circumscribed area, the bone at this portion of the mastoid being often so thin as to be almost transparent, in limited areas, and for small

FIG. 3.



Thick outer mastoid wall.

FIG. 4.



Compact outer mastoid wall.

spaces it may even be entirely wanting. The same multiplicity of variations as to contour of the bone, its density and thickness, is found on examina-

tion of the inner wall which separates the mastoid from the cranial cavity : the sinus (Fig. 5) may encroach boldly upon the space otherwise occupied by the mastoid cells (Fig. 6), it may be shallow and situated posteriorly, or well defined and curving sharply forward in its upper portion towards the mastoid antrum, and small and circumscribed spots of thin bone or even of absence of bone may be found here as well as upon the outer surface, while it is observed that a normal thinness of bone in the digastric fossa and at the tip of the mastoid is usually associated with a corresponding thinness on the inner mastoid wall and the tegmen mastoideum.

With such variations, the establishment of any general rules as to the relationship between the outer and inner mastoid walls and the differences in thickness of the cortical bone, valuable as such rules might be for surgical guidance, becomes very difficult, though it is generally accepted as an axiom that where the outer presenting mastoid wall normally is thick, thin bone will be found at the mastoid tip and in the digastric fossa, and also, in regard to the correspondence in contour of the outer and inner mastoid

FIG. 5.



Deep sinus.

FIG. 6.



Broad sinus.

walls, it would appear on the average that with a small mastoid protuberance, narrow from before backward and with a well-defined digastric fossa, which latter point is by no means easily determinable in many of the cases coming to mastoid operation, the sinus is usually marked in its outline and encroaches upon the mastoid cavity in its anterior portion towards the mastoid antrum. The question of symmetry of the two mastoid processes

in an individual becomes also of importance in relation to surgical procedure where one mastoid is diseased, and the general rule of symmetrical development is supported by such examinations as that of three hundred crania, in which marked asymmetry of the two mastoid processes occurred in

less than four per cent.¹ In the event of disease of one mastoid, with considerable swelling of the superincumbent soft tissues, a superficial tactile examination of the corresponding bone of the other side therefore may afford valuable information with reference to the conduct of a surgical procedure upon the affected side.

The variations (Fig. 7) in contour of the outer walls of the adult normal mastoid (Fig. 8) are quite equalled in diversity by the differences in size, shape, and arrangement of the subdivisions of the contained space, and in addition by the relations of this mastoid space to the mastoid antrum and middle ear, and the history of these variations is considerably increased when we add to our study of the subject that of the mastoid cavity in the child.

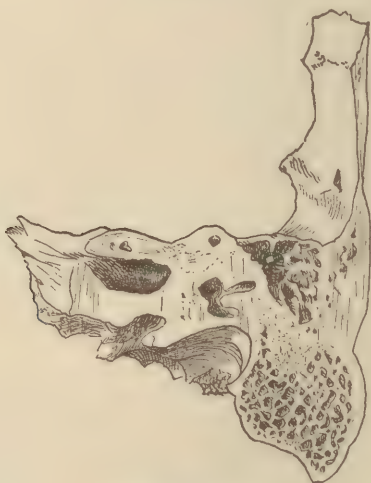
At its upper and posterior portion the tympanic cavity extends backward in the aditus ad antrum mastoideum, to curve still backward and

FIG. 7.

FIG. 8.



Outer wall of mastoid.



Outer wall of mastoid.

slightly outward in the mastoid antrum, which often represents, in the newborn infant, with the addition of a few cellular spaces superiorly posteriorly, the beginning of the mastoid cavity, which is later to develop downward and outward, forming the supplementary portion of the posterior wall of the external auditory canal. During the first twelve months the cellular formation proceeds, especially in the upper and outer portion of what is to be the base of the inverted pyramid of the mastoid proper, and after this period the development and proliferation, as it were, of the cells downward and

¹ Of the three hundred crania examined, ten, or three and one-third per cent., had markedly asymmetric mastoid processes; it was also found that when the mastoid process was small or the digastric fossa deep, the lateral sinus was deep and curved sharply forward towards the antrum in eighty-two per cent. of the crania, and of the total of three hundred crania examined, sixty-six, or twenty-two per cent., had either a small mastoid or deep digastric fossa with deep lateral sinus.

outward progress with a greater degree of difference in rapidity, in extent, and in the relationships of the cells than is found even in the development of the outer cortical portions of the mastoid. (Fig. 9.)

The mastoid process does not consist entirely of pneumatic cells continuous from the antrum, but frequently in part, and occasionally wholly, of diploetic substance, the pneumatic cells in the latter instance being few in number and confined to the neighborhood of the antrum; in some cases, also, the diploe is found only at the superior portion and at the tip of the mastoid, while in others it entirely surrounds a few centrally-situated pneumatic cells.¹

The mastoid antrum also shows great variation in its size and position; in some cases narrowing towards the point at which it passes over into the pneumatic cell-spaces of the mastoid, in others, projecting upward into the pneumatic cell-space of the upper mastoid portion as a direct continuation of the tympanic cavity backward, from which the pneumatic cell-spaces diverge downward through a small primary opening.

The lining membrane of the middle ear, which in the fœtus projects into the mastoid antrum as a pouch or invagination, is, in the child and the adult, continued into the mastoid cells as a highly-vascular non-ciliated pavement epithelium, which in both the pneumatic and the diploetic spaces serves the double purpose of lining membrane and periosteum.

In the mastoid antrum of both child and adult this membrane is thicker, affording, with the reduplications and mucous striæ which are here found crossing the lumen of this opening beyond the aditus, a means for the closure of the mastoid from the tympanic cavity under conditions of sudden or prolonged congestion.

Another normal condition of the soft tissues in the upper portion of the tympanic cavity, which may play an important part in mastoid disease, is the occurrence, in about eighty per cent. of all human temporal bones, of reduplications of the lining mucous membrane situated in the horizontal plane, often in two or three strata, the lowest seldom or never below the tendon of the tensor tympani, and the highest not much above the upper border of the head of the malleus; these horizontal folds or reduplications

FIG. 9.



Mastoid cells.

¹ According to Zuckerkandl, in 36.8 per cent. of the cases examined by him, the mastoid consisted, from its upper point to its lower boundary, of larger or smaller pneumatic spaces; in 43.2 per cent. it was formed, chiefly in its lower and posterior portion, of diploetic osseous substance, while the anterior superior part contained pneumatic cell-spaces; and, finally, in twenty per cent. the mastoid was wholly made up of diploetic, less frequently of sclerotic, tissue.

are usually firmer and more complete in the posterior portion of the tympanum, and serve, by shutting off the lower portion of that cavity, to make the upper portion practically a tympanic supplement to the aditus ad antrum mastoideum; practically, also, both these folds and the vascular lining of the antrum may play an important rôle in the event of mastoid implication requiring operation, in reference to questions of local phlebotomy and subsequent drainage.

PRIMARY INFLAMMATION OF THE MASTOID.

The diseases of the mastoid which are the most frequent and also the most important from a surgical point of view are the acute congestions and inflammations secondary to similar processes in the middle ear. *Primary inflammation* of the mastoid is of extremely rare occurrence, and is usually the result of injury or of exposure to severe cold, or may occur in the course of syphilitic disease.

A careful study of the few cases of reported primary mastoid inflammation on record suggests, in the light of more recent experience in this field of clinical investigation, the suspicion that in some of these there had been previous middle-ear inflammation as the inceptor of a chronic quiescent mastoid disease which was awakened to acute manifestations by the violence or exposure above referred to, while in others the implication of the mastoid cells possibly followed a superficial periostitis on the outer mastoid surface, with pus-formation, denudation of bone, and subsequent spontaneous perforation inward.

In the cases, also comparatively rare, of invasion of the mastoid cavity from the external auditory canal following and consequent upon an otitis externa diffusa or an otitis externa circumscripta of the posterior wall of the bony canal, the progress of events is much the same as in the cases last mentioned of so-called primary mastoid disease,—namely, a superficial, circumscribed periostitis, with death of the underlying cortical bone and of the contiguous cell-walls, the limitation of the process being accompanied by a circumjacent engorgement and swelling of the mucous membrane, similar to that occurring on a larger scale in the mastoid antrum in the event of extension of inflammation from the middle ear. This swelling, which plays a part in the isolation of the inflamed region, serves also to favor the subsequent separation of the resultant sequestrum, and in this class of cases of circumscribed mastoid disease the removal of a mass of separated bone from the posterior wall of the canal, either by spontaneous extrusion or by surgical procedure, reveals a limited cavity which rapidly fills in with granulation tissue. The sequestrum is usually characteristic in exhibiting a smooth wall on the one side and cancellated bony tissue on the other. The common starting-point of this inflammation, and the part usually included in the sequestrum therefor, is that portion of the posterior wall of the external auditory canal at or near the outer limit of the osseous canal proper, the sequestrum consisting sometimes of a small portion of the superficial

cortical surface of the canal-wall with a large mass of cell-walls, or of a large part of the canal-wall with but little of the cancellated tissue attached, and between these two extremes every possible degree of variation. The operative treatment in these cases must also vary in proportionate degree of interference, from the simple curetting of the wall of the canal through the meatus to the larger removal of bone which requires the reflection of the auricle forward by means of a semilunar incision behind it and along the curve of the concha. One occasional symptom in connection with these cases should always be borne in mind in reference to its possible misleading tendency, and that is the reference of the pain to a spot either in the centre of or upon the outer or posterior surface of the mastoid process, this reference of pain being accompanied by tenderness at or over the point indicated. The following cases are illustrative of this, and also of the two lines of treatment above mentioned.

CASE I.—A boy, sixteen years of age, strong and well built, had, as the result of a previous inflammation of the external auditory canal of the right ear, a small spot of bare bone on the inferior posterior wall. Discharge from this surface had continued through a small sinus for several weeks, with the accompaniment of redundant granulations which had been repeatedly snared and curetted away. The occurrence of severe pain, referred to the mastoid cells and accompanied by tenderness under pressure over the centre of that process, suggested the possibility of an invasion of the mastoid. There were no other local manifestations, the temperature was normal, and the general condition, except for the disturbance incident to the pain, was good.

Under ether an incision was made lengthwise of the canal, and all bare and necrotic bone was removed by means of the sharp spoon. The mastoid pain was, as the result of this operation, entirely relieved, and the wound in the canal speedily healed.

CASE II.—A girl, eighteen years of age, slender but well nourished, had lost the greater portion of the membrana tympani as a result of suppurative inflammation of the middle ear as a child. This had been followed for several years by a recurrent purulent discharge from the ear, and there had recently occurred, apparently without cause, except so far as a superficial periostitis was concerned, a swelling on the posterior wall of the canal, which had opened spontaneously with free passage of pus and a subsequent growth of redundant granulation tissue. The pain which accompanied this condition suggested in its character a necrotic process, but was referred generally to the mastoid region rather than to the diseased point in the canal, and had been so severe for several days as finally to call for surgical interference. In view of the considerable extent of bare bone in the canal, and the possibility of an extensive implication of the mastoid cells, it was decided, instead of operating through the canal, to reflect the auricle forward. This was done by means of a semilunar incision closely following the posterior border of the concha from a point well above the auricle to one just below it. Bleeding was readily controlled by means of nippers and hot

sponging, and a careful examination by means of the probe, followed by a sharp spoon, showed that the necrotic process was superficial, and that, while it included a considerable space on the canal-wall, it extended but a short distance into the mastoid cavity.

The superficial curetting, which in this case seemed to be all that was demanded, answered its purpose satisfactorily. The pain referred to the mastoid was relieved, and the patient made a good and speedy recovery.

CASE III.—A child, two and one-half years of age, had, in consequence of suppurative disease of the middle ear, mastoid symptoms, as exhibited by pain, redness, and swelling behind the auricle. This swelling had subsided, according to report, on three occasions coincidently with increased purulent discharge from the ear.

Examination showed the presence of a large sequestrum on the posterior superior wall of the canal, and a spot of circumscribed redness and fluctuation above and behind the auricle.

In view of the evident size of the sequestrum, the auricle was reflected forward, under ether, and the sequestrum (twenty millimetres long and twelve wide) removed, leaving a comparatively smooth cavity lined with firm granulation tissue, which rapidly closed.

When a local inflammatory process of this kind occurs in a subject otherwise in fair general health, the result in the majority of cases is, as above illustrated, the continuance of the localization and limitation to a definitely circumscribed area; but in persons otherwise debilitated, the natural attempt at localization is often futile; the small spot of necrosed bone becomes the starting-point of an extensive congestion of the mastoid lining membrane and a centre from which the necrotic process, following the preliminary congestion, rapidly extends to the remaining cell-walls. The following case may be cited in evidence, and illustrates also another point (to be mentioned later),—namely, the occasional value of the mastoid operation for the sake of free and rapid depletion merely.

CASE IV.—Mrs. —, twenty-eight years of age, with a nursing baby, was admitted to the Massachusetts Charitable Eye and Ear Infirmary with a circumscribed inflammation of the external canal of the left ear. The patient was anæmic, with a poor appetite, and had suffered much from sleeplessness. There was a circumscribed swelling on the posterior wall of the canal, incision of which liberated a small amount of pus and gave some relief from the pain from which she had been suffering for three days. Warm douching of the ear with an antiseptic solution was ordered, and the patient was put upon tonics and a generous diet. Under this treatment, and the favorable condition of rest in the hospital, the patient improved, with the exception of recurrence of pain in the ear on the third or fourth day after admission, which was referred to the spot in the canal previously incised, where a small spot of bare bone could be plainly felt. The patient's appetite was improved, and her temperature was normal, until two days later, when she had an increase of the pain in the ear, extending backward,

a sense of fulness in the mastoid, and a rising temperature. Twenty-four hours later the pain had increased; the temperature was 102.8° F.; the pulse was full and bounding; there was great sense of fulness in the head, with other symptoms pointing to decided congestion in the mastoid cells, and evident necessity for speedy and free depletion.

Under these circumstances it was decided not merely to make an incision through the soft tissues covering the mastoid, which were perfectly normal, with the exception of some œdema over the region of the digastric fossa, but also to enter the mastoid cells. This was done under ether by means of a broad drill, with the result of free venous hemorrhage from the mastoid lining membrane and relief from the alarming symptoms, followed by lowered pulse and temperature, the latter falling over two degrees within an hour after the operation.

In this case the necrotic process in the canal was subsequently relieved by curetting, and the wound upon the surface of the mastoid healed without supuration.

SECONDARY INFLAMMATION OF THE MASTOID.

The occurrence of mastoid disease from within secondarily to disease of the middle ear comes usually through the channel of the mastoid antrum and as a sequence of one of the three following conditions:

1. An acute congestion, generally in its inception a vaso-motor neurosis.
2. An acute catarrhal inflammation, originating with disturbance in the naso-pharyngeal mucous membrane and extending progressively, often rapidly.
3. A sequence of chronic suppurative disease in the middle ear, sometimes of long standing, and with or without already established necrotic process in that cavity.

The cases coming under the *first* heading, of acute congestion, are less frequent than those originating in an acute catarrhal inflammation of the middle ear; they usually have a history of precedent nervous over-tire, of depression following exhaustion, or, in the event of their being of local reflex origin, of severe exposure.

The pain usually occurs suddenly and unexpectedly, having been preceded by few premonitory symptoms, and rapidly increases in severity; it is not confined to the middle ear, but radiates forward and upward, and later, in the event of mastoid implication, backward; and, in addition to the continuous and more bearable pain, emphasizes the location and character of the disturbance by occasional severe paroxysms. An explanation of these symptoms is given on reference to what has already been said concerning the reduplications of mucous membrane in the upper portion of the tympanic cavity, and a consideration of the fact, furthermore, that the arterial supply of this region, coming as it does partly from branches direct from the carotid, affords an opportunity for sudden engorgement of the mucous membrane and submucous tissue in the event of suspension of vaso-

motor inhibition of general or local reflex origin. These folds may be classified, as to location, as follows: the horizontal, which have been considered by the clinician principally as obstructive to the drainage of the tympanic attic, and those—vertical or irregularly disposed about the stapes and round window—which have a clinical importance on account of their subsequent interference with the mobility of these parts, the third class being those of striæ and reduplications—principally the former—in the neighborhood of the mastoid antrum. The following description of the examination, in reference to this point, of two normal temporal bones, illustrates fully these first and second classes, the two of most frequent importance clinically. In both of the specimens it was evident that the middle ear had not been the seat of disease, and that the reduplications found were neither pathological in themselves nor rendered unduly prominent by any pathological process; they represented conditions which exist normally, to a greater or less degree, in more than seventy per cent. of human middle ears, and were therefore worthy of consideration from a practical point of view.

In the first case the mastoid cells, antrum, and tympanic attic were large and well developed, the mastoid antrum was crossed by numerous striæ, and there was, in addition, a reduplication of the mucous membrane, triangular in shape, with its apex attached to the superior border of the short process of the incus, and its base (two millimetres in width) attached by striæ to the inner, posterior, and outer walls of the mastoid antrum. There existed also the following reduplications of the mucous membrane: one from the anterior wall, at a height of about one millimetre above the level of the tendon of the tensor tympani, extending downward and backward to the tendon, and completely dividing the upper from the lower portion of the tympanic cavity anteriorly; above this, a second and smaller reduplication, extending from the base of the capitulum mallei downward to the tendon, and then forward to the centre of the first reduplication; thirdly, a small triangular fold, extending from the centre of the tendon along its border and the inner tympanic wall to the anterior crus and head of the stapes; and, finally, a firm reduplication, extending completely across the posterior portion of the cavity, and attached to and bounded by the stapes, descending process of the incus, lower border of the posterior pocket, and posterior and inner walls of the tympanum, the upper portion of the cavity being separated from the lower completely, with exception of an opening about one millimetre in diameter between the descending process of the incus and the malleus.

In the second specimen the horizontal reduplications were few in number and comparatively insignificant. The stapes had a fold passing from one crus to the other and closing the space between, with exception of a small spot at the apex of the triangular interspace; a second reduplication completely filled the space bounded by the eminentia stapedii, the tendon of the muscle, the posterior wall of the oval niche, and the posterior crus of

the stapes; there were, in addition, numerous striæ and a narrow fold anteriorly, the latter at the bottom of the niche and extending from the anterior crus to the corresponding niche wall, and a small reduplication from the head of the stapes at the insertion of the tendon, extending upward and backward, the plane of its surface corresponding to that of the tympanic wall.

The mucous folds in both these typically illustrative cases differed in clinical importance because of their structure as well as according to their position; the presence of fibrous tissue in greater or less degree affecting the resistance of the mucous reduplications and sometimes placing them on the plane, mechanically speaking, of ligaments.

Aside from the obstruction to free drainage of the upper portion of the tympanum, in the event of fluid exudation therein, the reduplications of mucous membrane of the first class may be considered as playing an important rôle in the etiology of those diseases of the tympanic attic the majority of which start with a suspension of vaso-motor inhibition in that region; for, taking into consideration the fact that these folds are really folds or reduplications, and that each presents a double mucous surface (with or without, usually with, connective tissue interposed), and that these folds curve to meet each other and the tympanic walls and structures to which they are attached, we can readily understand that the secreting and vascular surface of the tympanic attic may be easily doubled or trebled by their presence, a condition which serves to account for the rapid development of congestive disorders in the upper portion of the tympanum, and for the often excessive and copious serous exudation, without calling into question any contribution from the mastoid antrum. Indeed, the presence of folds of the third class, together with the known tendency to excessive engorgement and swelling of the mucous membrane in the antrum, favors a closure of that communication with the mastoid and effects the isolation of the middle ear, a series of conditions which cannot be found better illustrated than in the acute congestions of the tympanic attic of reflex origin, a typical case of the kind being one of those in which the congestion of the ear has followed some irritation of the corresponding side of the face,—exposure to cold, for instance,—followed shortly, sometimes within an hour, by severe pain in the ear and head, tinnitus, vertigo, and sense of fulness in the ear, the objective appearances being a transparent membrana tympani, very much distended, and congested in its upper portion and along the manubrium mallei; paracentesis of the more prominent inferior posterior quadrant of the drum-head giving vent to air, which escapes with a sharp hiss, and without relief from the pain, which first begins to decrease spontaneously, with the subsequent appearance of serous discharge. The effects in this class of cases, and also in those having almost invariably a precedent history of nervous over-tire, which evidence themselves first with a sense of fulness in the ear, giving place rapidly to pain, soon becoming unendurable, and in which free incision along the superior border of the mem-

brana tympani from the short process of the malleus backward, and deep enough to include the deeper layer of vessels going to form the inner manubrial plexus, is the only form of phlebotomy adequately efficient, cannot be accounted for on the supposition that we have to deal only with the limited area of vascular tissue which would be afforded by the normal tympanic attic without the addition of the mucous folds. In the first of the cases cited, it is evident that the sudden congestion of the mucous membrane so far restricts and decreases the lumen of the tympanum, and with such rapidity, as to compress the air within the remaining portion of the cavity, and with the removal of the air-pressure the serous exudation following, but with a sufficiently appreciable limit of time, shows that the compression of the air had been effected by the engorgement of the mucous membrane and not by the encroachment of fluid. In the second class of cases, the bleeding, sometimes of twenty-four hours' duration, followed by a copious serous discharge, long continued, is evidence of a larger area of supply than could be afforded by the tympanic attic alone, or explainable easily on any other hypothesis than that of a reinforcement, as it were, of its vascular area. That the swelling of the mucous membrane incident to this congestion is often, as has been said, so great as to close not only the Eustachian tube but also the mastoid antrum, and to compress the air in the middle ear, bulging the membrana tympani outward, is illustrated in the three following cases :

CASE V.—A boy, ten years of age, usually strong and well, had, in consequence of a previous illness, lost strength and appetite. After a period of unusual fatigue, which had been followed by a very sound sleep, he awoke in the morning complaining of pain in the left ear. This pain was paroxysmal, increased rapidly in severity during the two following hours, and extended from the point at which it had first been felt,—at the bottom of the canal,—into the mastoid region, and also forward and upward. When the patient was first seen, the membrana tympani, which was slightly congested at its periphery, especially at the upper border and along the malleus, was of a dull gray color with a reddish tinge from the engorged mucous membrane of the middle ear, and bulged outward, especially in its posterior segment.

A paracentesis of the membrana tympani at this latter point gave exit, not to fluid, but to air, which escaped under pressure, and which was followed by serous discharge half an hour later. The pain and the tenderness of the mastoid were relieved, and the temperature, which had previously been rising, began to fall with the appearance of this serous discharge. Under dry antiseptic dressings, rest, nourishing diet, and the administration of bromides, the case progressed favorably and the ear healed without supuration within ten days.

CASE VI.—A man, thirty-eight years of age, of full habit, had been exposed for an hour to a cold wind upon the right side of the face, both ears being warmly covered. Half an hour later, in a warm room, he began

to have a sense of fulness in the right ear. This rapidly increased, and was accompanied half an hour later by pain, which rapidly increased both in severity and in the extent of the area included. Examination of the ear showed some congestion at the inner end of the canal, especially at the upper border of the membrana tympani, and but little congestion on the membrane itself, which, however, was forcibly distended outward.

An incision made in the posterior inferior quadrant of the membrane gave vent to air, escaping with a sharp hiss, and being speedily followed by a sero-sanguinolent discharge, which continued for several days. The pain, which was relieved in part by the incision and consequent removal of pressure, was originally referred to the depth of the ear, but later extended to the mastoid region, and continued gradually decreasing, together with some tenderness post-aurally for several days.

In both of the above cases—one of general and the other of local reflex origin—the engorgement of the tympanic mucous membrane was so rapid, and so effectually compressed the air in the middle ear, as to press the membrana tympani outward on the one hand and prevent the occurrence of that serous exudation through the walls of the blood-vessels which is the subsequent measure of relief, and which was only possible when the paracentesis had effected its purpose. This condition of static air-pressure in the middle ear presupposes the closure of the Eustachian tube, demonstrable by the use of the air-douche and catheter, and of the mastoid antrum, which may be inferred from the similarity of the structural conditions in these two exits from the tympanum, and proved in the event of mastoid operation in cases of acute congestive inflammation when passage of fluid through the antrum is not readily feasible until the depletion consequent upon the operation has relieved the engorged lining membrane. While this closure of the antrum effectually prevents the passage of fluid from the middle ear into the mastoid, it by no means follows that the congested condition of the mucous lining, with its possible after-train of effects, is not continued into that cavity. The generally-diffused tenderness, which yields readily to local sedative or depletory measures,—the application of cold and of leeches, for instance,—is evidence of this, as is also the fact that the point at which the mastoid is first attacked and where the congestion is greatest, the vicinity of the mastoid antrum, is most likely to be the seat of a disease of the bone, which may remain as a congestive condition with more general than local symptoms until tissue-destruction originates the suppurative process, which is more readily recognized as demanding interference.

The following case illustrates the importance of an early recognition of this form of mastoid disease, the result of an acute congestion of the mastoid antrum in the midst of diploetic cells, with thin and vascular bony walls, and in close relation under the tegmen mastoideum with the meninges.

CASE VII.—A boy, nine years of age, fairly well and strong, had, six weeks previously to the time when first seen, an acute congestion of the left middle ear. The pain accompanying this congestion continued with in-

creasing severity for two days, and was finally relieved coincidently with the appearance of a serous discharge from the ear. This discharge soon ceased and the ear became dry, but the pain in the mastoid region, which had been complained of coincidently with the more severe paroxysms in the middle ear, now recurred, though in a moderate degree. The patient began to lose flesh, strength, and appetite, became pale, languid, and restless in his sleep. These conditions were followed at the end of a week by a slight rise in temperature, recurring late in the afternoon and subsiding on the following morning.

An examination of the membrana tympani showed it to be opaque and slightly congested at the upper periphery and along the malleus. There was considerable general tenderness of the mastoid region, reference of pain to the same region, rising evening temperature, and general malaise, and the head was carried somewhat stiffly and towards the affected side. A free incision of the membrana tympani being the first step indicated, it was made in the posterior superior segment, with the result of free bleeding and a very slight serous discharge, and was followed by a marked decrease in the temperature and relief of the mastoid symptoms.

That night the patient slept soundly, without opiates, but by the afternoon of the next day the mastoid tenderness, which was now especially noticeable over the mastoid antrum, and the elevation of temperature, had recurred. On the following morning the temperature was 100.8° F., there was a full heavy pulse, drowsiness, and complaint of pain in the frontal region.

Under these conditions, and with the evident insufficiency of the previous incision of the membrana tympani for the purposes of phlebotomy, perforation of the mastoid was decided upon.

Under ether, the usual incision behind the ear showed the outer soft tissues and the surface of the mastoid clear, healthy, and free from congestion. An opening into the mastoid, made by means of the drill and enlarged with the chisel, showed a clear cavity free from evidences of congestion; the operation was continued with a small drill and curette, and it was not until the mastoid antrum was nearly reached that soft and congested bone was found.

The thorough removal of this congested bone and the free bleeding incident thereto resulted in a speedy fall in the temperature and entire relief from the threatening symptoms; the patient steadily gained in strength, appetite, and flesh, and the wound healed without suppuration.

The inference to be drawn from the experience in the above case is, of course, in favor of an early recognition of the conditions indicating an acute congestion of the upper portion of the tympanum, of the possibly serious consequences of such a condition, and of the importance of prompt interference in the direction of forestalling the effort of nature to effect depletion of the congested area and afford relief, and it is in this class of cases that the preventive measures, when promptly applied, are of the most service.

These consist, as has been indicated, in incision of or cutting through the membrana tympani, either in its most congested or its most prominent part, in supplementing this incision by division of the horizontal folds in the posterior superior portion of the tympanum towards the antrum, in the application of cold over the mastoid surface, in local depletion by means of leeches or by cupping applied to the same region if pain or tenderness in the mastoid be present, and in internal medication and general hygienic measures. The relief from severe pain, referred to the inner end of the canal and the depth of the ear in an acute congestion of the upper portion of the tympanum and membrana tympani, obtained by the pricking of one of the small serous bullæ which, under such circumstances, frequently form upon the upper portion of the membrana tympani, suggests the relief obtainable in the event of a more extensive congestion by a larger incision into or through the engorged tissues.

As necessities to the proper performance of the operation either of puncture or of cutting in these cases there should be good illumination of the field to be operated upon, and absolute cleanliness, it being remembered that the incision to be made has reference not only to the immediate relief but also to the future hearing of the patient, and that the cavity to be opened, enclosed as it is by the swelling of its lining membrane and filled with serum or with compressed air, is practically aseptic.

As a preliminary, therefore, the external auditory canal may be cleansed of accumulations of epidermis or cerumen by means of a cotton-tipped probe dipped in a solution of corrosive sublimate (one to five thousand) or of carbolic acid (one to twenty); the hands of the operator and the aural specula should be likewise cleansed, and the instruments, consisting of a paracentesis needle, a narrow-bladed curved knife, and a thin double-edged spatula-shaped knife curved upon the flat, should be sterilized either by being immersed in an antiseptic solution and then wiped with fresh absorbent cotton or by passing through an alcohol flame, and just before using should be dipped in a saturated solution of boric acid in alcohol; this procedure has the advantage, in addition to that of cleanliness, of making the blade of the instrument more readily visible, from the deposit upon it of the fine white powder of the boric acid left by the evaporation of the alcohol. If the patient to be operated upon is a child, it should be firmly held not only as to its head, arms, and body, but as to its legs also, and the opening in the membrana tympani, whether a simple puncture or an incision along the superior periphery, should be made as speedily and with as sharp a knife as possible, the latter requisite being an important one for the consideration of the surgeon, since the tendency of the tensely-elastic tissues of the drum-head to yield readily under pressure makes the use of any but a properly-sharpened instrument either futile or productive of undue violence. In the adult, unless the head can be fixed with absolute firmness, or unless the patient is intractable, a head-rest or support is objectionable, because in such case the natural and instinctive tendency to

move away from the operator when the impact of the instrument upon the drum-head is felt is met by a resistance which causes a rebound towards the instrument and renders more liable the dangers, not necessarily serious in themselves, which attend paracentesis of the membrana tympani,—namely, disturbance of the stapedal articulation or breaking the point of the paracentesis needle or knife by forcible contact with the inner wall of the tympanum. If, from the severity of the general symptoms and from such local symptoms as extreme congestion of the inner end of the canal, especially on the superior posterior wall, accompanied by mastoid pain and tenderness, particularly over the region of the antrum, it seems advisable to take the further step of division of the posterior horizontal folds into the antrum, the first incision in the membrana tympani should be made in the superior posterior quadrant, from a point posterior to the short process of the malleus along the curve of the periphery under the posterior fold, to a point midway between the centre of the peripheral border of the posterior segment and the starting-point; through this opening the spatula knife, having a blade about six millimetres long in its curve and one millimetre wide, should be passed upward and backward, posteriorly to the descending process of the incus, into the mastoid antrum, and then swept forward and again backward in its withdrawal; bleeding and subsequent serous exudation should be encouraged and the pain relieved by dry warm applications.

The subsequent dressing of the ear, in the case either of simple paracentesis or of the more extended cutting, should have in view the maintenance of the aseptic integrity of the parts, and should consist in the introduction of drainage-wicks of dry absorbent cotton about four centimetres in length and large enough to fill the canal lightly, firmly rolled into shape with sterilized hands; the inner end of the wick should barely touch the membrana tympani, it should be carried into the ear until the patient flinches from the pressure and then be slightly withdrawn, and the outer end should be coiled in the concha and covered with a pad of absorbent cotton, this outer dressing being replaced as often as it becomes moistened with serum, and the whole dressing removed at intervals in proportion to the freedom of the discharge.

In default of a sufficient relief from the mastoid symptoms by the procedure above described, or coincidently with this treatment, if the occasion demands, a more direct influence upon the mastoid circulation may be exerted by direct depletion or by the application of cold. Of the effect which may be had from the former, not only upon the mastoid, but also upon the intracranial circulation, the following case is an example.

CASE VIII.—A young man, nineteen years of age, who had grown rapidly during the year preceding, and had also been actively engaged in college studies, was suddenly attacked with pain incident to an acute congestion of the tympanum. Paracentesis of the membrana tympani gave vent to a free sero-sanguinolent discharge, with corresponding relief, and the

case progressed favorably, with a gradual decrease in the serous exudation, for several days, when, following a day of too much reading and consequent fatigue, the discharge from the ear increased and was followed speedily by a renewal of the pain and tenderness in the mastoid, by a marked rise in temperature accompanied by a correspondingly slow, full, and heavy pulse, and decided drowsiness and slowness of speech. Six leeches were applied over the region behind and above the ear included in the superficial area of the outer mastoid surface, and within half an hour after the application of the last leech the pulse had risen in frequency and had become soft, the temperature had fallen, and the pain and drowsiness had given place to natural sleep.

In default of this means of depletion, the Heurteloup artificial leech or the cupping leech of Bacon may be used, or the Wilde incision, which consists in a cut over the mastoid through the soft tissues to the bone, posterior and parallel to the auricle, may be resorted to.

This simple incision is of much value and often all-sufficient as a surgical procedure in certain cases, but should, in all cases in which it is resorted to, be regarded also as possibly only the first step in a more extended operation. The cases in which it is in itself sufficient are principally those acute congestions where it serves its purpose of prompt depletion, in superficial post-aural abscesses, and, according to the opinion of some surgeons, in those cases of mastoid abscess where nature has been left sufficiently long in charge of the case to have effected a spontaneous perforation of the outer cortex.

Treatment.—The general treatment should include rest in an even temperature, light, non-stimulating diet, freedom from noise and excitement, and, for internal medication, the administration, if required, of a saline cathartic, of the bromides, and of an opiate when needed. In addition to this treatment, one of the most important abortive measures is the continued application of cold to the mastoid region; this may be done by means of light compresses or pieces of cloth laid upon a block of ice in a bowl at the bedside, thence transferred to the space behind the ear and replaced as often as the sense of cold decreases; by the application of an ice-bag, or, better still, by means of the Leiter coil, which consists of a short piece of small, thin lead tubing bent twice or thrice upon itself and retained in the shape given it by a thin, flat lead matrix. A tube of this sort adjusted behind the ear, kept in place by a light bandage, and having for inflow and outflow rubber tubes, through which passes by siphonage a steady stream of cold water, affords a ready means of maintaining for the part to which it is applied a continued low temperature. This method of treatment is of especial value as a remedy when used in the early stages of acute mastoid congestion and before a suppurative process has begun; it is also sometimes of value as a palliative measure in the acute exacerbations which occur in the course of more advanced mastoid disease; but in both instances its use should be accompanied by observant precautions, since the relief from pain afforded by

this measure leads to a neglect of other symptoms which may indicate an advance of the mastoid disease and the need for more decided treatment. The application of cold compresses, of the ice-bag, or of the Leiter coil may sometimes with advantage be continued for several days, but its use should always be accompanied by careful observation of the pulse, temperature, and other symptoms. The relief from pain by this means is often delusive, so far as its indication of the true physical condition is concerned; a rise in temperature, either with or without a corresponding change in the pulse, should ordinarily be the signal either for a careful physical examination of the patient in reference to other possible pyrexie causes, or with regard to the advisability of a change in the treatment of the aural disease, it being borne in mind that the temperature is in itself by no means to be taken as a sure indication of the mastoid condition.

The following cases are quoted to serve as illustrations of some of the points mentioned and of the relief afforded by depletion and the application of cold in the early stages of mastoid disease, while the last of the cases given in this group shows the importance of considering the possibility of other than mastoid disease as the cause of alarming symptoms which might have been referred to an aural cause.

CASE IX.—The patient, a man, thirty-four years of age, had an acute inflammation of the right middle ear, beginning about three weeks before the time of his first visit, which was made on account of recurrence of pain in the ear, extending to the mastoid and occasionally towards the vertex. There was a muco-purulent discharge from the middle ear, coming through a nipple-shaped projection in the posterior superior portion of the membrana tympani; there were also slight mastoid tenderness and a temperature of 99.6° . The patient was ordered a cocaine ear-bath, bromide of potassium internally, and cold applications over the mastoid, to be continued as required. Between the date of the first visit and a period of five weeks later, when the mastoid symptoms had entirely disappeared, there were occasional recurrences of pain, relievable by local applications.

CASE X.—Man, forty-five years of age, had an acute inflammation of the right middle ear one month before the date of his first visit. The external auditory canal was clear, the membrana tympani opaque and slightly reddened posteriorly and superiorly, and there was some mastoid tenderness.

The patient was given bromide of potassium internally, and was ordered to rest as much as possible and to make cold applications to the mastoid. Under this treatment he improved, and the pain in and tenderness of the mastoid became less, recurring, however, at irregular intervals until four weeks after the first visit, and at all times readily controlled by cold applications.

CASE XI.—Woman, thirty-one years of age, was first seen with acute congestion of the upper portion of the right tympanic cavity, as indicated by redness and swelling of the posterior superior portion of the membrana tympani and the inner end of the canal. The pain, which was very severe,

had begun forty-eight hours before the time of the visit, and now extended towards the mastoid antrum, towards the vertex, and forward into the temporal region. There was mastoid tenderness, especially over the point corresponding to the antrum and in the region of the digastric fossa; the temperature was 100.2°. A long curved incision was made in the posterior superior portion of the membrana tympani, following the posterior fold, with a resultant free bleeding and sero-sanguinolent discharge. With the use of dry drainage-wicks in the canal and cold applications to the mastoid, together with bromides internally, the congestion gradually subsided, and the patient made a good, though slow, recovery.

CASE XII.—A woman, thirty years of age, was first seen with a history of pain in the right ear of six weeks' duration, without aural treatment. Two weeks before the date of the visit a discharge from the ear had occurred, but without abatement of the pain, which had finally extended into the mastoid. There was considerable œdema of the posterior wall of the external auditory canal, which was filled with a muco-purulent discharge; there were a well-marked nipple-like protuberance on the membrana tympani and much tenderness and some redness of the mastoid.

The treatment consisted in the application of the cold Leiter coil and in douching the ear with a warm corrosive solution every two hours. Two days later there had been no pain for the twenty-four hours previous, the œdema of the canal-wall was less, the tenderness of the mastoid much less, and the Leiter coil was discontinued.

One week later there was but very slight discharge from the ear, no œdema of canal-wall, and the nipple had nearly disappeared. There was no tenderness of the mastoid, and the general condition was much improved.

Six weeks later the patient, who had not been seen in the interval, reported at the infirmary with symptoms of chronic periostitis of the mastoid.

CASE XIII.—A woman, forty years of age, was admitted to the infirmary with a history of severe pain in and about the right ear, together with tinnitus and deafness of three weeks' duration.

Examination showed a profuse muco-purulent discharge coming through an opening in the anterior inferior quadrant of the membrana tympani, œdema of the posterior superior canal-wall, tenderness of the tragus and mastoid region, and some redness of the latter. A leech was applied to the tragus and the cold Leiter coil to the mastoid.

On the following day the tenderness of the tragus had entirely, and of the mastoid region nearly, disappeared, with the exception of a small spot near the canal.

Three days later the œdema of the canal-wall had slightly increased, and the use of the warm douche in the canal was ordered in addition to the Leiter coil.

Three days later the patient was reported to have slept well all night without opiates, for the first time since the ear-trouble began; the discharge

from the ear had decreased and all tenderness had disappeared, and two weeks later the discharge had ceased also.

CASE XIV.—A woman, thirty years of age, convalescent from influenza, was first seen on account of an acute suppurative inflammation of both middle ears, which began five days previously and had become complicated by acute mastoid trouble on both sides, with severe pain extending towards the vertex and down into the neck. There was œdema of both canals, tenderness of both mastoids, and a temperature of 102.5°.

The treatment consisted of rest in bed, the cold Leiter coil to both mastoids, warm douching of both ears as often as once in three hours, and a leech to the left tragus.

By the next day the pain in the right mastoid had nearly gone and the temperature had fallen to 100°, while on the day following the pain and tenderness in both mastoids had nearly disappeared, the discharge from the ears and the œdema of the canal-walls was very much less, and the temperature had fallen to 99°.

The Leiter coil was omitted on the fifth day, and five days later the patient was discharged from treatment.

CASE XV.—The patient, a sailor, thirty-two years of age, had an acute inflammation of the left middle ear five months before the date of his first visit, with discharge, which had continued. For a period of four months he had, at irregular intervals, pain so severe as to keep him from sleeping. The pain had latterly increased, and he was admitted to the infirmary with the left mastoid evidently larger than the right, reddened, and tender on pressure. The left external auditory canal was filled by a large fibrous polyp. This growth was removed to its base, and syringing and alcohol instillations were ordered. On the next day the mastoid region was more tender, especially near the tip; the syringing and warm alcohol instillations were continued, and, in addition, two leeches were applied to the mastoid and followed by the continuous cold Leiter coil.

Twenty-four hours later there was neither pain in the mastoid nor tenderness except at one point over the antrum, and at the end of two days he was discharged from treatment, with the left mastoid still larger than the right, but neither red nor tender.

CASE XVI.—A woman, thirty years of age, was admitted to the hospital with a sero-purulent discharge from the left ear of three weeks' duration, accompanied by pain in, and tenderness over, the mastoid region; there was general malaise and slight elevation of temperature, but no symptoms pointing to other than the aural cause for the general symptoms. Under rest, diet, careful cleansing of the ear, and cold applications to the mastoid, the pain and tenderness were both much relieved and the post-aural swelling decreased.

At the end of a week the patient had a marked chill and a sudden rise of temperature to 102° F.; there was, however, neither change in the character or quantity of the discharge from the ear nor increase in the

local mastoid symptoms, which subsequently continued to improve, the true cause of disturbance being an acute nephritis.

1. The abortive measures above mentioned are, as far as symptoms indicate, equally applicable to those cases of middle-ear disease accompanied by implication of the mastoid which come under the second category, the acute catarrhal inflammations, though it is by no means certain that in this latter class they are equally serviceable, since the one is essentially and primarily a vaso-motor disturbance, while the other is accompanied from its inception by trophic changes which do not come within the limit of conditions amenable to the influence of a vaso-motor stimulant. In the acute catarrhal inflammation of the middle ear, therefore, it is of practical importance to determine as accurately as possible the extent to which the disease is of local origin and progressive character, and the degree in which it may be complicated by a vaso-motor neurosis of general or reflex origin exaggerating its primary congestive stage, the danger of mastoid implication being greater in the latter instance and the abortive measures more applicable.

2. In the ordinary course of an acute catarrhal inflammation of the middle ear the primary congestive stage is of short duration, and is accompanied or rapidly followed by considerable swelling of the mucous membrane and by increased activity of the mucus-secreting glands. The pain which accompanies the attack is less sudden in its onset and less severe in its paroxysms than in acute congestion of vaso-motor origin; the appearance of the ear also indicates a difference in condition; by the time the pain, the sense of fulness and tension, and the tinnitus aurium have drawn the attention of the patient to the necessity for relief, an examination of the ear usually shows a more generally diffused congestion at the inner end of the canal and of the membrana tympani, with less œdema about the superior periphery of the latter than is found in the more acute congestive cases. The difference in origin of these two types of inflammation of the middle ear, both of which may lead to mastoid complication, accounts for the symptomatic conditions. In the first instance, the cause may be one affecting profoundly the nervous system with a resultant suddenly-exhibited effect in a suspense of vaso-motor inhibition, which allows congestion of the mucous membrane of the upper portion of the tympanum to occur with corresponding rapidity. In the other cases, whatever the general cause may have been, its local exhibition is, first, usually in a portion of the mucous tract remote from the middle ear,—that of the naso-pharynx, for instance,—from which it progresses through the medium of the Eustachian tube to the middle ear, the congestion of which may, in part, be regarded as of the nature of a blood-stasis. The closure of the Eustachian tube by the swelling of its lining membrane brings about a degree of impact of the opposing walls which materially interferes with the return of blood from the middle ear through the venous circulation to the lateral pharyngeal veins, and results in a congestive result of slower progress than that which comes from an opposite cause,—vessel-dilatation of vaso-motor origin. In like manner,

the progress of the trouble towards the mastoid is slower and more progressive, and the swelling of the mucous membrane in the mastoid antrum, already mentioned, plays in this class of cases an important rôle in the natural effort to protect the latter cavity from implication in the disease of the middle ear, it being often found, in the event of operation, that this swelling prevents the passage of fluid from the opening made into the mastoid cells through the middle ear after a period of twenty-four hours, or as long a time as it may take for the depletion incident to the operation to relieve the congested mucous membrane in this locality.

In the acute vaso-motor cases the mastoid complication occurs simultaneously with the congestion in the middle ear; in the acute catarrhal cases the mastoid complication may be considered as a true sequence of the middle-ear disease. Another important factor in the acute catarrhal inflammation of the middle ear, which has a bearing on the cause of the mastoid complication, is the freedom of exit provided for the incident secretion. In the first or congestive stage, this secretion, being simply serous, finds ready exit through even a small perforation in the membrana tympani; but with the subsidence of the congestion and the awakened activity of the mucus-secreting glands the discharge becomes less serous, more mucous, and requires a larger opening for its exit. The swelling of the mucous membrane also, by decreasing the lumen of the opening in the membrana tympani, still further interferes with the passage of the fluid either through the perforation or through the Eustachian tube. A familiar feature under these conditions is the formation on the membrana tympani of a nipple-like swelling of which the centre is the perforation reduced to a small sinus by the encroachment of the swollen mucous membrane, the pressure of the fluid within pushing the circumjacent portion of the membrane outward in its effort to force an escape.

The effect of this accumulation of pressure in the middle ear is often indicated, after a nipple of the membrana tympani of this kind has formed, by the return of the pain which had previously subsided with the occurrence of the original opening; this recurrent pain, moreover, being paroxysmal, and occurring suddenly and severely, when from any cause the excreted fluid is of greater quantity than can be delivered through the Eustachian tube or the nipple-like opening in the membrana tympani. Under this condition, in these cases, the liability to implication of the mastoid increases, and should be met by appropriate treatment either in dilatation or free incision of the nipple and corresponding provision for the release of the contained secretion.

3. The disease in the mastoid cells, starting from the middle ear and mastoid antrum as an inflammation of the lining membrane, varies greatly in different cases as to its rate of progress and the direction in which it shall make itself externally manifest, these differences depending upon the structure of the bone forming the mastoid walls and cells and the degree of implication of the bone in the inflammatory process. The whole course of

a case, beginning with the onset of the acute middle-ear disease and terminating with an operative opening of the mastoid cells for the release of contained pus and the removal of necrotic bone, may extend over a period of only a few days; or, on the other hand, the acute middle-ear symptoms may subside, the perforation in the membrana tympani, whether surgical or spontaneous, may heal, and there may remain for weeks such symptoms only as a sense of fulness in the ear, occasional pains referred to the mastoid region and to the vertex, possibly slight elevation of temperature, and either very slight tenderness over the mastoid or none at all, according to the thickness of the cortex or the location, for the time being, of the more acute part of the inflammatory process. Under these conditions, unless the true state has been sooner determined and the direct surgical course towards relief resorted to, at the end of an indefinite period, a fluctuating swelling on the outer surface of the mastoid or in the region of the digastric fossa, or possibly in the soft tissues in the neck, gives evidence that a spontaneous perforation of the mastoid at one or other of the points indicated has released the contained pus.

The changes which occur in these cases of slowly progressive inflammation of the mastoid cells are of *two* kinds: those which finally manifest themselves externally with the evidence of a suppurative process are usually accompanied by a *limited necrosis* of the bone, the surrounding tissue being thickened and consolidated, while in the cases in which the inflammatory process has subsided without suppurative evidence, the bone is found to be greatly thickened, in some instances even to the extent of almost entire obliteration of the mastoid cells, a *hyperostotic process* analogous to that found in the cases of diffuse periosteal inflammation of the external auditory canal.

This condition of the mastoid is one which would be most naturally expected in those cases coming under the third category of mastoid implication as the result of chronic suppurative disease of the middle ear. The length of time in which such a process may persist in the upper portion of the tympanic cavity, distinctly localized, and without evidence of a liability to extension to contiguous parts, proves the existence of the natural process of isolation, which is evidenced in the relation to the mastoid cavity by the accumulation in the antrum of those masses of exfoliated epithelium so frequently removed from the tympanum in these cases, and which, in this less accessible portion, remained in the form of an *epithelial plug* completely blocking the mastoid antrum.

The opportunity for inspection of the posterior portion of the tympanum and of the antrum, which sometimes occurs in caries of the posterior superior wall at the inner end of the osseous auditory canal, shows the laminated epithelial plug of this kind to be limited in its location principally to the antrum itself, though it may form a part of a desquamative process including the whole of the upper portion of the tympanum, and serving as an effectual barrier against the passage of fluid from the tympanum into the mastoid cells.

Active mastoid complication in connection with chronic suppuration of the middle ear is most likely to occur as the result of an acute exacerbation of the middle-ear disease. The latter may also have been accompanied in its course by a chronic inflammatory process in the neighboring cavity, leading to the thickening of the cell-walls, and providing the condition, already mentioned, of an acute inflammation of the bone of limited area in the centre of a *sclerosed mastoid*.

The external symptoms of this form of mastoid disease are, as would be expected, much less evident than in any of the acute forms which have been previously mentioned; the indications for operation, however, are the same in the demand for the release of contained fluid and the removal of diseased tissue. In the acute cases the inflammation and destruction of the cell-walls may include the whole of the mastoid cavity, which is found to be filled, when opened by operation, with pus, granulation tissue, and necrotic bone, or a spontaneous perforation of the outer mastoid wall may have been added to the destruction within; while in the chronic cases it may be necessary to penetrate through a considerable depth of sclerosed bone before the true seat of the acute inflammation, which demands operative interference, has been reached.

In the case of mastoid sclerosis, also, operation may be demanded on account of the continued pain which is the result of intrinsic pressure, and for the relief of which the removal of a portion of the sclerosed bone, by means of the trephine, the drill, or the chisel, may become necessary.

In still another class of cases of mastoid disease the operation for opening the mastoid cavity, with a special view to gaining access to the mastoid antrum, may be necessary,—namely, in those cases, the result of long-continued chronic middle-ear disease, in which the exfoliation of epidermis in the middle ear and mastoid antrum has extended to the mastoid cells, with a formation of the resultant *cholesteatoma*. This tumor, which is regarded by some observers as a true heteroplastic neoplasm, and by others as the result merely of an epithelial desquamative process, and which is found not uncommonly in the upper portion of the tympanic cavity, and, as already mentioned, in the form of an epithelial plug in the mastoid antrum, may be found in the mastoid, including only a few of the cells in its upper portion, or may include the whole cavity to the obliteration of all the interior cell-walls.

A mass of this kind, formed by the superposition of fold upon fold of exfoliated epithelium, may, through the pressure it exerts, result in a gradual destruction of the surrounding tissues, its own limitation being only the extent to which the exfoliative process can progress, or the occurrence of an inflammation which its presence awakens, and which leads to symptoms directing attention to its existence and calling for interference for its removal.

CASE XVII.—Man, fifty years of age. This patient was first seen in consultation, with acute inflammation of the right middle ear and with a

muco-purulent discharge through a perforation in the posterior superior segment of the membrana tympani; the discharge was free, and the previous pain in the ear had ceased with this occurrence; there was no mastoid tenderness, and the patient was improving in general condition from the consequences of an attack of influenza. The discharge from the ear decreased, and finally ceased, during a convalescent trip to the South, upon his return from which the ear was found to be clear, dry, with the perforation healed and the hearing improved.

One month later the right membrana tympani appeared clear, except for a slight reddish tinge showing through the posterior superior portion, and the hearing was somewhat better than when last seen; over the centre and upper portion of the mastoid was a deep-seated, tense, fluctuating swelling. The pain for the two previous nights had been severe, and the temperature was 99.8° .

Operation upon the mastoid was advised, and was done under ether on the afternoon of the following day, the first step being a semilunar incision in the membrana tympani, running from the short process downward and backward to below the median horizontal line.

The incision behind the ear followed the curve of the auricle from the line of its upper margin to the tip of the mastoid; neither ligatures nor forceps were required, broad retractors and sponging with very hot water being sufficient to control the bleeding, as in the majority of cases. From the upper end of the cut about one-half drachm of pus escaped, and here was found a small, rough depression of the bone, which below this point was firm, hard, and clear.

Careful searching of the rough depression by means of a fine probe and explorer failed to reveal any sinus opening into the mastoid, but the symptoms and conditions pointed so conclusively to the existence of some such opening, however microscopic, and so forcibly recalled the experience of presumably similar cases where a sinus from the upper portion of the mastoid had been traced downward and inward, that the opening was made with a drill in this case also, about one-half inch below this rough spot.

The opening, made with a small and a large drill, passed through firm bone and was enlarged upward in the cortex by means of the chisel and mallet, the soft bone searched for being found only when close to the antrum.

The operation, which was unusually long, lasted one hour, and was concluded by dry dressing, without syringing. The patient slept well that night without opiates, and on the following day syringing through the antrum from the opening in the mastoid brought away large masses of desquamated epithelium and of cholesteatomatous material. Three days later the discharge from the ear had ceased and the perforation in the membrana tympani had healed.

OPERATIVE TREATMENT.

The operation of opening the mastoid process, though it has in the majority of cases to deal with the liberation of pus and the removal of the contents of a septic cavity, should preferably be done under the antiseptic conditions proper to other surgical operations. The ear should be syringed, the region surrounding the mastoid should be shaved, and the whole surface thoroughly scrubbed with soap and water, and just before operation washed with an antiseptic solution, the hairy portion of the head being covered with a tightly-stretched band of rubber tissue fastened with a clamp, or with a rubber cap made for the purpose. After etherization, which should be brought to full narcosis, the patient should be placed upon an operating-table or bed, with the head and shoulders slightly raised, and in such position as to permit of free access to the part to be operated upon by the surgeon and one assistant; the neck and shoulders should be covered either with rubber tissue or with towels wrung out in some antiseptic solution. While it is perfectly possible to make a simple opening into the mastoid process with a stout knife, a drill, a chisel, or even a gimlet, the variety of conditions which may be found to require further attention, and the relief which may be afforded both immediately and in the hastening of complete recovery by further interference, demand a larger armamentarium.

The *instruments* probably required for the convenient performance of the operation consist of scalpels, one with a very slender, narrow blade; one-half dozen or more of ordinary nippers; two broad curved retractors; one narrow retractor with a hook end, to be used in lifting the periosteum or in breaking thin edges of bone (Fig. 10); large-sized Bowman probes; a fine steel probe; a curved steel explorer (Fig. 11); hand-drills (Fig. 12), three sizes, three, four, and six millimetres wide respectively; large, medium, and small sharp spoons (Figs. 13 and 14); and gouge-shaped chisels (Fig. 15).

In view of the possible complications which may attend mastoid disease, either in the extension of the inflammation inward or outward and downward into the soft tissues of the neck, the aural surgeon should be prepared, in the event of either of these contingencies, to go farther than the simple mastoid operation, and, as circumstances demand, open either the cranial cavity for the purpose of securing exit of pus and free drainage, the lateral sinus for the removal of thrombus, or the triangle of the neck, with ligation of the necessary vessels. The instruments, previously boiled in a soda solution, should be placed in shallow cloth-covered trays, grouped with advantage, according to their uses in the different stages of the operation; at one end of the tray may be placed the knives and retractors, next the drills, gouge, and chisels, and finally the sharp spoons, together with the explorer, curved director, and probes, while the nippers, artery forceps, and ligatures may be placed in another tray or bowl. The instruments should be submerged in a one-to-twenty carbolic solution, if possible, a half-hour before the opera-

FIG. 13.



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FIG. 12.



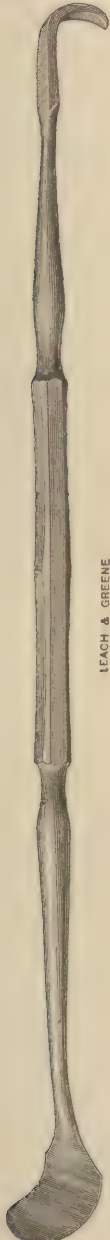
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FIG. 11.



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FIG. 10.



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FIG. 15.



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FIG. 14.



tion, and immediately preceding it the trays should be flushed with boiling water.

Boiling water should also be provided in an irrigation used for flushing during, and final douching after, the operation, and poured into a bowl containing previously-boiled and carbolized sponges. The hands of the surgeon and his assistants should be thoroughly cleansed, and portions of the bed or table with which they or the instruments may come in contact covered with antiseptic towels.

The incision through the soft parts should depend for its size and location upon the demands of the individual case, it being always borne in mind that within certain reasonable limits it is impossible to make it too large and very easy to make it too small. As a rule, it should extend from a point opposite the upper border of the concha downward to the mastoid tip, following the curve of the conchal insertion, the advantage of this over a straighter incision being a better opportunity afforded for uncovering a large surface of bone with the least disturbance of the soft tissues. Where there is swelling in the region of the digastric fossa, indicating this as a point to be reached, on account of disease of the bone, the incision should be carried farther backward, and, in the event of gravitation of pus from an opening in the tip of the mastoid into the posterior triangle of the neck, extended downward along the posterior border of the sterno-cleido-mastoid muscle. In the simple incision over the mastoid the cut should be made as uniformly complete as possible, the knife being entered perpendicularly to the surface at the upper end of the cut and carried downward in contact with the bone throughout its length, until at its lower end, when the knife should be gradually withdrawn, thus affording a slanting surface through the soft tissues which favors subsequent drainage. The incision below the mastoid, either posteriorly or inferiorly, however, should be governed in its character by the exigencies of the case.

Hemorrhage from the flaps should be controlled, ordinarily, by means of nippers and sponging with very hot water, and by the use of the broad, smooth retractors, which may also be used to expose the bone freely, in order that its surface, in default of any special indication of disease, may be carefully searched by means of the explorer and fine probes for the purpose of determining, if possible, the existence of any small sinus which might otherwise escape detection.

The first opening into the bone, when this is still imperforate, may be made by means of the smallest hand-drill, enlarged by larger drills, and then farther extended by means of the gouge and chisel, the chiselling being done preferably with a small, light mallet, striking short, frequent blows; as cutting done in this manner is rapid, with the least shock to the parts and with less danger of splitting from a thick into a thin portion of the bone, or the gouge and chisel may be used alone from the beginning of the operation upon the bone; one advantage of the use of the drill is usually in the saving of time previous to the use of the chisel, and the particular

form of drill here depicted has this advantage, that, being held as it is near the blade, a slight deviation of its point is represented by a much more appreciable movement of the handle end, and it is in this respect better than the shorter hand-drills and than any form of mechanically-operated drill, especially when its use in the interior of the mastoid comes into consideration.

In point of fact, in so delicate a procedure as that of the thorough exploration and excision of the mastoid, any advantage which may be gained from the greater force or rapidity of operation of a drill actuated by a motor is counterbalanced by a certain loss of that accuracy of touch which may be of great importance to the successful issue of the case.

Within the mastoid cavity the operation should be continued, so far as possible, solely by means of sharp spoons, the drill and the chisel being used to supplement them only, and the curetting continued, as a general rule, until the diseased bone is entirely removed; in some cases the removal of a portion of the inner wall or of the entire mastoid is necessary.

The *spoons*, as shown in the engraving, are unfenestrated, and made with a stout shank and sharp cutting edge to the bowl, which is, moreover, extended in a curved lip, permitting the passage of the spoon behind spiculæ or thin pieces of bone or sequestra, and their removal by its withdrawal; in the event, also, of an opening in the inner mastoid wall, a sharp spoon with its rounded bowl and projecting tip becomes a valuable instrument, since it may be used to work from within outward with the least danger to important soft tissues; the handle of the spoon should always be gouged or otherwise marked by some smooth variation of its surface on the side towards the cutting edge of the bowl, that the hand of the operator may be constantly apprised of the direction of the cutting edge of his instrument. This method of roughening the handles of cutting instruments which are to be used beneath the surface, and therefore under governance of touch, has a double advantage, in addition to that already mentioned, of affording a firm grasp of an otherwise smooth surface, and of doing this without providing an opportunity for the lodgement of septic material. The handles of all the instruments used are preferably of metal, smooth finished, and with a smooth, gouged, or undulating surface in place of the usual serrations, the maker's name even being omitted.

The *gouges* may with advantage be used in two sizes, the larger, which would be used preferably on the outer wall of the mastoid or where the bone is hard, having its tip squared for the space of two millimetres, in order to afford a better hold on the surface attacked than could be had with the rounded tip of the ordinary gouge.

At the conclusion of the operation, which in a great majority of cases has been immediately preceded by incision of the *membrana tympani*, the wound and the ear should be thoroughly douched with warm boiled water, an effort being made to secure a free passage through the antrum, except in certain of the acute cases with very considerable swelling of the mucous

membrane in that region ; previous experience having shown in some of such cases that recovery is more rapid without this interference.

The ear itself should be carefully dried, plugged with a pledget of cotton or baked gauze, and baked-gauze dressings applied over the mastoid region and the ear, in some few cases corrosive sublimate being used instead of the baked gauze ; in the majority of cases neither drainage-tubes nor gauze need be introduced into the wound nor stitches used. Twenty-four hours after the operation, unless previously required, the wound may be reopened and explored by means of a probe, and syringed with weak corrosive or, preferably, weak permanganate solution, subsequent drainage being insured sufficiently in all cases by the daily probing, the wound being allowed to close in from within and above as rapidly as possible ; care being taken to preserve, however, by use of the probe at the daily dressing, a sufficient external opening to permit of free drainage and to allow the use of the curette, should any small spiculæ of bone, detached subsequently to the operation and detected by the probing, require removal.

With the cases thoroughly curetted, this was rarely necessary.

The various stages of the mastoid operation, after the preliminary shaving, scrubbing, and the cleansing of the ear, may be briefly recapitulated as follows :

First, such free incision of the membrana tympani in its posterior quadrant or of reduplications in the posterior portion of the tympanum, or both, as shall insure a free passage from the mastoid antrum downward and outward.

Secondly, the incision behind the ear, for which will be required scalpels, retractors, nippers, artery forceps, silk or catgut ligatures, and a periosteum scraper.

Thirdly, the examination and perforation of the mastoid, for which may be required sharp steel explorer or probe, hand or mechanical drill, chisel, or gouge with mallet, or small trephine.

Fourthly, the operation within the mastoid, for which may be used the drills and chisels before mentioned and, preferably, the sharp spoons.

The general course of the operation within the mastoid cavity should be governed by the exigencies of the occasion, but its general direction should be inward and forward at such an angle as to reach the mastoid antrum.

The variations of the mastoid operation beyond the limits already given consist in the entrance of the mastoid from the posterior wall of the external auditory canal, the auricle being reflected forward for that purpose, and in the perforation of the antrum from the outer surface, to which the mastoid operation may be made secondary.

The complications of mastoid disease which may require surgical interference beyond the boundaries of the mastoid region, which, on account of their intimate and consequent connection with it, must of necessity come within the province of the aural surgeon, are those which attend the exten-

sion of the mastoid inflammation, or of its products, either inward or upward into the cranial cavity, or outward or downward into the tissues of the neck.

The former contingency implies the necessity of opening into the cranial cavity either from the mastoid cavity upward and forward anteriorly to the ridge of the petrous process, or posteriorly through the wall of the sinus (the latter in cases of thrombosis), or directly into the cranial cavity through the thin portion of the squamous process above the external auditory canal. In the two former instances (a continuation of the mastoid operation) the first opening in the mastoid may be enlarged either forward or backward by means of the chisel and rongeur forceps.

In the latter instance the trephine may be used in one or two places, and the openings enlarged or united, if necessary, by means of the rongeur, care being taken to avoid pricking or otherwise wounding the dura, which should be carefully examined for any evidence of inflammation, either in injection, clouding, thickening, or adhesion to the cranial wall; exploration in regard to the latter point being conducted by means of the smooth probe carried downward along the cranial wall to the points on the anterior surface of the petrous bone through which invasion from the mastoid cavity and middle ear most commonly takes place.

In default of detecting any extra-dural source of the symptoms which have called for interference, the dura may then be opened. This should be done carefully by means of dissecting-forceps and scalpel, special care being taken to avoid wounding any of the large veins, hemorrhage from which is often with difficulty checked.

Extensive opening of the dura, where this is done for exploratory purposes, should be avoided on account of the subsequent hernia of the brain.

In the great majority of cases of burrowing of pus from the mastoid cavity into the tissues of the neck there is found to be the common combination of a thick mastoid cortex on the outer surface with thin bone at the tip and in the digastric fossa, from which points the direction taken by the pus in gravitating downward is governed both by the location of the point of exit and the guidance of the muscles and fascia; pus issuing from the tip of the mastoid usually making its way downward along the line of the sterno-cleido-mastoid muscle, posteriorly thereto, but sometimes passing forward into the anterior triangle; while pus making its exit at the digastric fossa extends backward under the deep fascia and follows down the back of the neck, unless its cumulative pressure forces a way through one of the lacunæ exteriorly into the anterior portion of the posterior triangle. In the event of swelling over the digastric fossa, tenderness at this point upon deep pressure, and other evidences both of involvement of the mastoid tip and of presence of pus in the neck, the incision, beginning at the usual point on the upper portion of the mastoid surface, should be carried downward and backward posteriorly to the point of insertion of the sterno-cleido-mastoid

muscle, and downward into the neck as far as may be requisite to secure thorough drainage; or if the pus has already pointed or gives indication of so doing in the lower part of the neck, the mastoid incision should continue only to a point sufficiently below the mastoid tip to permit of the bone being reached from below as well as from above, and may be supplemented by incisions into the neck opposite the lowest point to which the pus has gravitated, this cutting being done either upon the probe or upon the finger introduced into the pus-cavity from the wound above.

The method of operation and the subsequent course of treatment are illustrated in the following cases:

CASE XVIII.—A woman, fifty-five years of age, two months previous to admission to hospital had an acute inflammation of the right middle ear, accompanied by serous discharge which soon ceased; the pain in the ear which had accompanied the first attack did not, however, decrease, but continued and extended into the mastoid. Four weeks later swelling in the neck appeared, accompanied by increase of pain and of the mastoid tenderness. When first seen the patient had a temperature of 100° and a pulse of 80, and was able to be about during the day. There was no swelling of the external auditory canal, the membrana tympani was free from congestion, somewhat opaque, and there was a slight amount of fluid in the tympanum. The head was carried towards the right, and could not be elevated on account of contraction of the sterno-cleido-mastoid, which had continued for three weeks; there was a hot, non-fluctuating swelling extending from the mastoid midway to the clavicle, and tenderness of the mastoid tip only. Paracentesis of the right membrana tympani gave exit to clear serum. A leech was applied to the mastoid, followed by cold applications, continued for three days, which relieved the pain and tenderness without, however, affecting the increasing swelling of the neck. The operation which, under these conditions, together with the further symptom of a rise in temperature to 101.8° , was decided upon consisted of an incision behind the ear from a point above the auricle posteriorly over the tip of the mastoid, which revealed bare bone at the mastoid tip and in the digastric fossa. This was removed by means of the chisel and sharp spoons, and this was followed by free curetting towards and into the mastoid antrum, fluid syringed into the mastoid passing out freely at the external auditory canal. A small amount of pus came away from the mastoid, and a large pus-cavity was found extending downward into the neck in three directions, as determined on exploration with a probe and finger, one pocket terminating at a point behind the mastoid muscle, another in front of and slightly below this, and a third posterior to both; these sinuses were opened, thoroughly dilated, syringed out with weak corrosive solution, and medium-sized rubber drainage-tubes passed in at the upper opening, where they were held together by a safety-pin, and out at the lower openings. Dry dressing was applied, and the syringing repeated daily until a week later, when the large tubes were removed and replaced with smaller ones by inserting the ends of the smaller

in the upper ends of the larger, fastening them by a single catgut suture, and drawing them through.

Five days later, the patient improving, catgut drains previously soaked in tannin solution were inserted in the same manner in place of the tubes.

The second case stands also in evidence of the slow progress of an inflammatory process from the mastoid antrum to the tip, and of the importance of the free incision of the membrana tympani in such cases, even when that membrane gives no evidence of an acute process in the middle ear.

CASE XIX.—A man, forty-eight years of age, had often an acute inflammation of the middle ear, with serous and sero-mucous discharge which soon subsided, pain in and tenderness over the mastoid region subsiding and recurring at intervals for a period of six weeks, at the end of which time a slight swelling appeared behind and below the mastoid tip. Coincidentally with the appearance of this swelling there was decrease of the pain and of the mastoid tenderness. Four weeks later, with occasional attacks of pain in the interval, the swelling was found to have extended downward into the neck, to be non-fluctuating, and not tender upon pressure. The right external auditory canal was normal, there was no discharge from the ear, and the membrana tympani was pale and normal in appearance, with the exception of a thickening on its superior posterior portion.

There was neither redness, swelling, nor tenderness over the mastoid surface, and but a slight tenderness on deep pressure over the digastric fossa. The temperature was 99° ; the pulse, appetite, and digestion were good. Warm applications to the neck were followed by increase of swelling in that region, and as the symptoms pointed to slowly progressing inflammation of the mastoid, with abscess in the neck as a consequence, operation was decided upon, and preceded by a crescentic incision in the posterior superior portion of the membrana tympani. The incision behind the ear was carried over the digastric swelling and about five centimetres below it along the posterior border of the sterno-cleido-mastoid muscle.

The outer surface of the mastoid was found to be firm and smooth, but the tip was roughened both on its outer and its under surface. An opening made with a drill through the hard outer surface to the depth of four millimetres entered the mastoid cells, and, being enlarged by means of the chisel, permitted the use of the curette upward and forward along the line of softened bone into the mastoid antrum, and downward and backward until the whole tip of the mastoid was removed. At this point the carious process had extended so far along the posterior and inner portion as to necessitate the removal of a part of the wall of the sinus, which was accompanied by free hemorrhage, checked spontaneously by the bulging of the membranous wall into the cavity in the bone. After the removal of the diseased bone to a smooth surface, and dilatation of the sinus leading into the neck, accompanied by hemorrhage of the occipital artery, checked by plugging, exploration of the wound by means of the probe and finger showed a pus-cavity extending inward and backward as far as the occipital protuberance

and downward posteriorly to a distance of about six centimetres from the point of removal of the mastoid tip, where a second incision was made by cutting down upon the finger used as a director. After thorough irrigation with a weak corrosive solution, a drainage-tube was placed in the posterior opening and stitched to the upper lip of the wound, and the larger incision was plugged with iodoform gauze and dry gauze and cotton dressings supplied.

On the following day the temperature, which, just previous to the operation, had been 103.5° , had fallen to normal, and the patient's general condition was much improved, and there was free muco-purulent discharge from the middle ear in justification of the incision made in the membrana tympani.

On the second day the removal of the iodoform plugs and dressings showed free, clean cavity, with but a few drops of pus.

CASE XX.—A woman, twenty-five years of age. The early history of the case was indefinite; but three weeks before admission to the infirmary she had much pain in the left ear and corresponding side of the head, and was delirious for one night. On examination, there was found a large, firm polyp, completely filling the canal; this was removed under ether; was found to spring from the posterior tympanic wall, with a mass of retained secretion behind it and bare bone in the tympanic attic.

Two days later the patient was nervous, apprehensive, somewhat apathetic at intervals, and complained of severe pain in head and back of neck, this pain becoming later definitely located in the left frontal and parietal region, and having periods of remission and exacerbation. The pupils were equal but small, and reacted to light and accommodation, and the movements of the eyeball were unimpaired. Examination of fundus showed beginning of optic neuritis in the left eye; the tongue was put out in the median line, and there were no signs of paralysis elsewhere; the pulse was intermittent and varied in strength and rhythm; during the night of the same day there were two intervals of severe and persistent vomiting.

On the following day all the symptoms were intensified, and once there was a sudden collapse in which the extremities and face became cold and the pulse fell to 50 and could scarcely be felt.

During the two following days the patient grew worse, had chills and a temperature of 106° , violent delirium and occasional periods of collapse; the pain in the head continued, and the skull became tender at a point just over and in front of the left auricle.

The operation, which, under these circumstances, was urgent, consisted, subject to the advice of consultants, in a trephine opening two centimetres in diameter and the same distance above the superior curved line of the occipital bone; this opening was enlarged by means of the rongeur until it was five centimetres long on the horizontal line and two and one-half centimetres in width; the dura, which was normal, bulged without pulsation. An opening in the dura showed the pia to be also normal, and was followed

by immediate hernia of the brain. The subdural space and the brain-tissue were thoroughly explored by means of probe and director, but no pus was found. Subsequent exploration by means of aspirator needles carried inward, forward, and downward, and once into the lateral ventricle, also failed to liberate the pus, which was found, at the autopsy, five days later, to form a circumscribed, flattened, subdural abscess, covering the first and second left frontal convolutions, and in such position, therefore, that a trephine opening made farther forward would have directly liberated it, and would also have given access to a carious spot upon the tegmen tympani.

As the result of the operation and the corresponding relief of pressure accompanying the brain hernia, the patient was restored to consciousness for thirty-six hours, with but slight intervals of delirium, amounting, in all, to but one hour; there was also relief from the pain, nausea, and vomiting.

CASE XXI.—A man, twenty-one years of age, strong, well built, of good general health, had a discharge from the right ear of one week's duration, accompanied by severe pain referred to the depth of the ear.

On examination, there were found to be slight tenderness of the pre-auricular region and decided tenderness of the mastoid tip and antrum; the canal was filled with purulent discharge exuding through a well-marked nipple-like protuberance in the posterior inferior portion of the membrana tympani, and the temperature was 101° .

On the following day, the patient having in the mean time been admitted to the infirmary, there was slight pain only, and no tenderness of the mastoid; during the morning of the same day there was a slight chill, accompanied by a rise of temperature to 104° , and two hours later to 106° . This elevation of temperature was unaccompanied by pain or nausea, and the condition of the ear was, to all appearances, the same as when first examined.

A thorough general examination revealed nothing abnormal in either the thoracic or the abdominal cavity, and the mastoid operation was decided upon in consequence of the sudden rise in temperature.

The operation consisted in the usual procedures, the bone of the cortex and outer portion of the cells being found to be normal, and softened bone found only on approaching the antrum, which was thoroughly curetted, communication being freely established with the middle ear.

The effectiveness of the operation for the proposed purpose was shown by a fall in the temperature of three degrees within two hours after the removal of the patient from the operating-room, and by a corresponding relief of the other symptoms for a period of five days, at the end of which time the condition changed; the patient became suddenly comatose, with a diffusive and irregular pulse and corresponding respiration; there was twitching of the right side of the face, especially of the right upper lip, and also of the thumb and first two fingers of the right hand, this hand also being occasionally suddenly flexed; there were marked clonus reflex of both hands and forearms, an apparent paralysis of the tongue, and inability to swallow;

the pupils were dilated but equal, and reacted to light; there was neither nausea nor vomiting, and no apparent evidence of pain.

Curvilinear incision was made from the root of the zygoma to a point over the mastoid, and trephine opening two centimetres in diameter made directly over the external auditory meatus. The dura bulged slightly, but was apparently normal and without pulsation; careful examination of the petrous surface by means of the blunt probe revealed no carious bone, but an incision through the dura was immediately followed by a jet of clear serum, which spirted to a distance of between two and three feet and continued to exude whenever the subdural space was explored; no pus was found, and the brain was not entered.

As the result of the operation, the patient was restored to consciousness, and conversed rationally for five or six hours, after which time he relapsed into his former condition, and died thirty-six hours after the operation.

The autopsy showed acute, diffuse, purulent leptomeningitis of the right hemisphere.

The precautions to be observed in the performance of any form of the mastoid operation, as distinguished from the simple opening of the mastoid, aside from those which pertain under ordinary surgical rules and which include an intimate knowledge of the structure and relationships of the complicated temporal bone, are those which relate to interference with the facial nerve in its passage through the base of the petrous bone and along the posterior tympanic wall below the antrum, and those which concern possible injury of the sound-transmitting structures of the middle and internal ear; the latter consideration especially emphasizing the conclusion that this operation, as well as the differential diagnosis of the various forms of mastoid disease requiring interference for their relief, come most appropriately within the scope of the aural surgeon.

DISEASES OF THE INTERNAL EAR:

ACOUSTIC AID AND AURAL HYGIENE OF THE VERY DEAF, PARTIAL MUTES, AND DEAF-MUTES.

BY EDMUND D. SPEAR, M.D.,

Aural Surgeon, Massachusetts Charitable Eye and Ear Infirmary ; Aural Surgeon to Out-Patients, Boston City Hospital ; Instructor in Otology, Boston Polyclinic, etc., etc.

PART I.

DISEASES OF THE INTERNAL EAR.

THE advance in knowledge of the causes which produce diseases of the ear claiming the discerning skill of the aurist made since the discovery of Trötsch's mirror can be readily appreciated when we take an old list of diagnoses and compare it with those of to-day. The usefulness of this comparison is evident when we observe the tendency to separate the unknown from the known, and place in proper position the lesion or functional derangement which, because unseen, was considered equally intangible. While a large percentage of patients were said to be simply deaf, or were considered the incurable victims of "nerve-deafness," and accordingly left untreated, we have learned that the vast majority of ear-patients are affected with diseases of parts of the ear accessible to the sight and touch. Diseases of the labyrinth proper, then, are extremely rare, and are to be observed and discovered only by inference and the process of exclusion. Affections or disorders of function of the internal ear induced by, dependent upon, or accompanying diseases of other portions of the ear are very common, and it will be through the study of these that the greatest advances in otology will be made during coming years.

The anatomical arrangement of the labyrinth, with cochlea, vestibule, and semicircular canals, comprises, as now understood, two distinct and separate organs, though placed in juxtaposition by a wonderful provision of nature's economy. In a portion called the cochlea is situated an apparatus or organ prepared for the reception of impressions received from without, constituting the peripheral organ of hearing. Another portion, curiously made and placed behind this, forms also a peripheral apparatus devoted to the intrinsic purpose of a space-organ. For the understanding of the functions of these two organs it will not be necessary to do more than recall to mind their general anatomy and refer to it in a

general way, without confusing ourselves with the many names which have been given them.

The organ of Corti, with its thousands of rods, is placed within the spirally-twisted snail-shell prepared for the nervous expansion of the cochlear branch of the auditory nerve. The so-called vestibular branch of the same nerve, which might receive a different name, divides into two portions, and is spread out upon the ampullar enlargements of the membranous semicircular canals, and is distributed to the parts of the vestibule including the saccule and utricle.

We may consider the architectural structure of the labyrinth as follows. In order that the delicate filaments of Corti's organs should be fully protected against all ordinary shocks and accidents, they are placed in a bone of closest texture and firmest consistence in the case or shell of the osseous cochlea, which contains, furthest from its exterior, the membranous spiral canal, along whose sides is stretched the narrow fillet upon which they rest. Lying in the fluid of the endolymph contained in membranous tubes surrounded by the perilymph, the terminal expansion of the cochlear nerve is in position to receive vibratory impressions through the sound-conducting apparatus, transferred through the membrane of the oval window to the fluid within the vestibule. The physical explanation of the reception in the cochlea of air-vibrations and their interpretation as sounds has been fully made by Helmholtz, and the references to functions of the different parts of the labyrinth need no further discussion, since all questions regarding them have been so clearly decided by that observer.

The larger and more noticeable portion of the labyrinth is made up with three semi-elliptical tubes or canals, which, according to their relative position to their planes, have received the names of superior, horizontal, and posterior semicircular canals. By the joining of the extremities of two of these, the superior and posterior ones, there have been produced five instead of six terminal openings, which are enlarged into bulbs and receive the names of ampullæ. Instead of a complicated series of convoluted tubes, these are simply curved canals varying in their positions to correspond with all the different planes. The superior canal is a vertical one, the horizontal is nearly horizontal, and the posterior is inclined at such an angle to the horizontal plane as to give the intermediate plane between the two. Along the sides of the tubes themselves no nerves are found, but they are found at their ampullæ: the inference would plainly be that molecular vibrations in the fluid of the tubes should be felt or taken notice of. And thus we can easily understand the function of such an apparatus. Nothing could apparently be more simple in arrangement, or better suited for its purpose. Helmholtz speaks of this apparatus as follows: "As regards the cilia in the ampullæ, the investigations of Goltz have made it extremely probable that they, as well as the semicircular canals, serve for a totally different kind of sensation,—namely, for the perception of the turning of the head. Revolution about an axis perpendicular to the plane of

one of the semicircular canals cannot be immediately transferred to the ring of water which lies in the canal, and on account of its inertia lags behind, while the relative shifting of the water along the wall of the canal might be felt by the cilia of the nerves of the ampullæ. On the other hand, if the turning continues, the ring of water itself will be gradually set in revolution by its friction against the wall of the canal, and will continue to move, even when the turning of the head suddenly ceases. This causes the illusive sensation of a revolution in the contrary direction, in the well-known form of giddiness. Injuries to the semicircular canals without injuries to the brain produce the most remarkable disturbances of equilibrium in the lower animals. Electrical discharges through the ear, and cold water squirted into the ear of a person with a perforated drum-skin, produce the most violent giddiness. Under these circumstances these parts of the ear can no longer with any probability be considered as belonging to the sense of hearing. Moreover, impulses of the stirrup against the water of the labyrinth adjoining the oval window are in reality ill adapted for producing streams through the semicircular canals."

"A determinate pitch, to a more remarkable extent, may also naturally result if the pressure itself, which acts on the stirrup of the drum, alternates several times between positive and negative. And thus all transitional degrees between noises without any determinate pitch and compound tones with a determinate pitch may be produced. This actually takes place, and herein lies the proof, on which Herr S. Exner has properly laid weight, that such noises must be perceived by those parts of the ear which act in distinguishing pitch."

The number of the rods of Corti is supposed to exceed many thousands; and if the supposition is correct, that individual rods serve for single tones, this is a correct estimate. It should be remembered that a few very short rods are placed upon the membrane, which is stretched from the extension of the modiolus near the vestibule at the base of the osseous spiral lamina, and the theory that these shorter rods vibrate to tones of very high pitch receives confirmation in the case where the pathological processes have extended directly from the tympanum to this portion of the cochlea. While sound-vibrations, as such, are always likely to affect the cochlear nerve without producing any shock to the vestibular nerve to disturb equilibrium, it is true that sudden, unexpected sounds, or the continuous and tiring action of noises, will cause disturbances in this sense, which, if intense, are shown by attitudes of fear, motions indicating uneasiness, or even marked effects upon locomotion. Reference is here made to such physiological states as may be induced in individuals with normal ears. The ear in health, and this usually even in sleep, is prepared for the reception of all sounds, and in proportion to the mental habit, or to education, can transmit such impressions to the brain. We do not hear, however, with our ears, nor do we locate ourselves in space with our semicircular canals, for it is always necessary that impressions upon these organs

shall be transmitted to the brain and be perceived by it to receive interpretation.

The passage of these impressions takes place along three distinct nerves, and two of these have different centres in the encephalon from which they emanate. The microscopical appearances of the nerve-bundles themselves are of such a distinctive character that it is possible to distinguish one from another. (Schwalbe.) From this fact we understand the causes of certain phenomena observed as dependent upon the condition of the organs included in the so-called auditory apparatus.

We have seen by the study of the arrangement of the labyrinth that we shall be called upon to consider disturbances in function of organs which do not in the least resemble one another in action. With an organ of hearing we shall find changes which will interfere with its function as a receiver and transmitter of those impressions which we must call sounds, and shall likely find that from various causes this organ may produce such impressions within itself as to give rise to the subjective symptoms which are called hallucinations. With an organ for the perception of a sense of space, more properly speaking for localization and maintenance of equilibrium, we shall obtain, as a result of a disordered state, manifestations which require observation to decide their source because of their great extent and the influences which such disturbances have upon the organism as a whole.

The importance of the function of these semicircular canals in the economy will further claim attention when considering the affections and diseases which are to be located in them. It will be necessary to cite more fully the results of certain experiments and to explain more in detail the deductions from some clinical observations made by the writer.

It is now accepted that the canals form a peripheral space-organ, and, further, it has been suggested by Höggyes that they act through the centres in the brain as regulators of the movements of the muscles of the eye and probably of all the muscles of the body for the preservation of equilibrium. The truth of this strong and far-reaching assertion will need further clinical demonstration; but enough has been learned to give evidence of the intimate relationship between the ear and the eye in these particulars.

When individual canals are irritated, sensations of dizziness and of a tendency to move the body in one direction are noticed. If light pressure be made upon the fluid in the vestibule by touching the membrana gently, a rocking sensation of the head from side to side may be felt, indicating transference of pressure to the ampulla of the superior canal. If pressure be made upon the membrane of the round window, sensations of dizziness with inclination to fall backwards are brought on from pressure on the ampulla of the posterior canal. It is not possible to transmit pressure to the horizontal canal alone, and when strong pressure is made upon the fluids of the vestibule, general dizziness without sensations of motion in any special direction is induced.

It will be interesting and instructive, especially in the differential diagnosis of affections of the different portions of the auditory apparatus, to consider the causes of the various symptoms which may be presented for explanation.

We recall the two organs described as making parts of a so-called auditory system,—one an organ of hearing, the other an organ of space,—the first for the reception of sonorous vibrations, the second for the perception of impulses. We shall have, then, perversion of hearing and disturbances in equilibrium. Sonorous vibrations may be conveyed to the hearing organ from parts of the auditory apparatus concerned in bringing these vibrations to the organ itself, and we may therefore hear sounds made within the outer ear or in the structures near these. The sounds made by the flowing of blood in the arteries and veins, and by the movements of the muscles, may be heard when, from any peculiar condition of the ear, these sounds have resonant air-chambers or conducting media to intensify them. There may be heard various intrinsic sounds, like the purr of the carotid, the hum of the anæmic “bruit,” the snapping of the muscles, or the resonance of one’s voice,—all caused by the driving in, as it were, of the sounds normally made in the head, instead of their passing out. But we may have sounds produced in the organ of hearing itself and interpreted by the brain as external sounds. These usually high-pitch tones are induced by pressure upon certain terminal filaments of the cochlear nerve in the organ of Corti. Nature has provided, as we shall see, for the maintenance of a normal degree of tension within the labyrinth, and, unless the ear becomes greatly diseased, the pressure is uniform and seldom changes so as to bring about a mechanical disturbance which would be interpreted as just stated. The causation of ringing sounds is thus readily understood, and should long ago have received the simple explanation which it deserved, from analogy.

So very simple does this seem that it hardly merits explanation. Every one knows what it is to “see stars,” when the terminal ends of the optic nerve are irritated by pressure upon the globe of the eye. If pressure may cause sight in the organ for seeing, why will not pressure produce sound in the organ for hearing?

We find, therefore, whenever the tension within the labyrinth becomes greater than normal from pressure within or from changes in the external ear or middle ear with pressure from without, there are sounds described by the patient as those of ringing, hissing, or similar sounds of high pitch.

We may decide with a fair degree of accuracy from the character of the sound whether it is intrinsic or extrinsic, and we shall be able to locate it and state its probable cause. It is often the case that patients cannot describe or locate the noise themselves, but a study of the causes and careful reference to its character will bring a decision. It is not well to make eager inquiries of any patients for the presence of noises in the ear; but the examiner should understand their relationship to the disease of the ear, and when speaking of these symptoms refer to them in an off-hand way,

because in many instances patients have become apprehensive and alarmed unnecessarily by having had their attention directed to noises which, previously to examination, they had taken little note of. These remarks apply with force to the cases in which labyrinthine tinnitus is found, for this kind of tinnitus from disease of the internal ear is least amenable to cure.

The diseases which affect the hearing by lesions within the labyrinth, and which ought to be considered as belonging to it alone, are necessarily few in number. Those in which there is an extension from without the labyrinth are far more numerous, but, as has been implied, are not as frequent as has been supposed. Affections of the auditory nerve in its course will take place in all the diseases or affections in which are to be found changes in the blood-supply or nutrition of the brain through which this nerve passes. We may, therefore, include as probable causes for loss of hearing, dependent on lesions within the cranium, all the results of traumatism, such as concussion, hemorrhage, effusion, purulent collections, inflammations, new growths, cysts, and so forth. Of the causes for deafness from diseases of the nerve within the cochlea; anæmia, more properly spanæmia, hyperæmia, and effusions, hemorrhagic or serous, and exudations with new formations, bony growths and deposits; these last are very unusual in the labyrinth alone.

CONCUSSION OF THE LABYRINTH.

Complete deafness by concussions of the labyrinth may occur where indirect violence acts upon the nerve through the bone. It has been known to be produced by blows upon the mastoid process, and by falls in which the shock is received through the occiput. In these cases it is supposed that the loss of hearing is brought about much in the same way as the cessation of vital action in certain of the lower animals, sometimes in man, by a peculiar action upon molecular motion, though exactly what happens cannot be explained. There are no accompanying visible changes in other parts of the ear.

In making a diagnosis of concussion of the labyrinth to account for the loss of hearing, the history of the case, with the absence of signs of local injury to the ear, taken together with the fact of there being perhaps subjective symptoms, as tinnitus, must be considered. As the prognosis is unfavorable, no treatment can be recommended.

There are certain forms of shock to the internal ear, included by some authors under concussion to the labyrinth, which ought rather to be termed *compression* of the labyrinth. The sudden compression of the air in the auditory canal may force the chain of bones so quickly inward that the fluids within the internal ear may receive greater pressure than can be accommodated for by the safety-valve action of the membrane of the round window, and concussion results. Discharge of artillery, especially of the heavy ordnance now in use upon war-vessels, direct blows from the hand, blows from hard missiles, all producing concussion, may be followed by

injuries to the labyrinth which may become permanent. A peculiar affection of the auditory nerve is sometimes brought about by the shock of harsh noises, and there remains in the ear a permanent after-impression similar to that induced in the eye by the action of bright light. Ears subjected to disagreeable intense noises may retain an impression of these tones, and the labyrinth may, besides, become seriously impaired if there is any disease of the middle ear. Normal ears, though deaf after such exposure, recover after a few hours of rest.

The form of labyrinthine disease which is so peculiar to those employed in factories, boiler-shops, and other noisy places is always secondary to the accompanying middle-ear disease, is attended with great deafness, and is never amenable to treatment. Much, of course, can be done to prevent the extension of the disease, and more in the prevention. The stopping of the external canals is usually practised by the workmen, and probably aids in retarding the progress of the labyrinthine disease.

Diseased ears are liable to receive serious injury when subjected to concussion from blows or falls, and it is not unusual for patients who had, previously, heard fairly, to apply for relief of very great deafness, which has been supposed to have been caused by the accident. For example, in cases where a thickened (sclerosed) condition of the mucous membrane existed in the tympanum, and the capsular ligaments around the joints of the ossicles had become stiffened, it is easy to understand how a sudden jarring of the parts might cause greater displacement of the transmitting apparatus, with a fixation of the stapes against the membrane of the oval window, and consequent greater compression of the labyrinthine fluids and suspension of the function of hearing.

This fact of the susceptibility of diseased ears to dangerous consequences from shocks renders it very necessary to subject patients to treatment as soon as possible after the receipt of the injury, in order to prevent the retention of the ossicles in their misplaced position.

The diagnosis of affections of the auditory nerve or the auditory centre within the cranium must rest upon the history, with the knowledge of the location and course of the nerve. We shall be aided by examinations of other organs, especially in cases to be referred to under other heads,—cerebral anæmia, hyperæmia, hysteria, and so forth. In the use of the different tests for the decision of the presence of any hearing-power, the test of the tuning-fork is usually relied upon, but it will require a considerable degree of expertness, both in judgment and in observation, to make the decision correct, and it will be well to call attention to the fallacy of concluding that, in any given case, the impairment of bone-conduction, or its entire absence, will always mean an affection of the labyrinth or some central lesion.

Such a case as this illustrates the meaning: absolute loss of hearing for air- or bone-conduction in the left ear of a gunner exposed to the sudden concussion succeeding the discharge of a brass field-piece. The tuning-fork was heard in the better ear. Appearances of the *membrana tympani*, with

a history of ringing in the ear for some months previous to the accident, gave evidence of an old disease of the middle ear. A diagnosis of simple compression of the labyrinth, with fixation of the stapes in the oval window, was made, treatment by strong inflation through the catheter was applied, and hearing for the voice and watch became at once about two-thirds normal.

Under the diagnosis of diseases causing deaf-mutism will be mentioned the theory upon which should be based the etiology of such diseases, and it will be shown that it is probable that in only a few cases can this portion of the ear be diseased, except by extension, and that idiopathic diseases of the labyrinth are not only very rare, but very hard to discover by the means at present used by aurists.

HEMORRHAGE FROM THE INTERNAL EAR.

The significance of the appearance of blood at the auditory meatus is always such that even a small amount excites remark. Those cases in which hemorrhage may occur from the internal ear are not infrequently observed, and the blood may appear outwardly or remain effused within the labyrinth or tympanum. All these cases are of traumatic origin. Falls or blows upon the head, by breaking the petrous bone or by causing contusions, may be attended with rupture of blood-vessels and exudation of blood. The importance of the sign should not be forgotten, though usually it is considered of more value in diagnosis than is warranted. Hemorrhage and serous discharge from the ear have always been considered diagnostic signs of fracture at the base of the skull. Hemorrhage from the ear has the most importance in cases where it is continuous and lasts for several days, or when from the additional sign of loss of hearing, coupled with the history of bleeding, it indicates fracture. The oozing of blood from a fissure or seam in the bony canal or annulus tympanicus, whether continuous with a rupture in the membrana or not, would at once prove the presence of a fracture.

The continued flowing of blood from an ear, with no lesion discoverable after it had ceased, as in a case observed by the writer, would also show fracture as the cause. On account of the liability of pressure from the effused blood and disorganization of the structures within the labyrinth, the prognosis is very unfavorable.

A case of hemorrhage into the tympanum, but affecting the labyrinth by direct contiguity, was one in which, after receiving a severe blow upon the ear, a man became very dizzy, was slightly deaf, and noticed blood coming from the ear. Obligated to remain in bed thereafter for a few days, he found, upon recovery, that he was able to walk, but unable to lie upon his back, as in a barber's chair, without rolling backwards and falling to the same side. Examined by the writer in the Ear Department of the Massachusetts Charitable Eye and Ear Infirmary two weeks after the accident, only a few masses of dried blood were found in the auditory canal. A dark-bluish spot having been seen through the posterior half of the mem-

brana, and it having been decided that the symptom of dizziness was due to pressure upon the round window, an incision was made through the membrana and a blood-effusion found. This was situated upon the anterior and lower edge of the bony opening of the window, and some blood was pressing upon the membrane of the window. With some difficulty a portion was removed, and the patient no longer felt like falling backwards, and was dizzy only when throwing his head quickly backwards.

The diagnosis of pressure through the fenestra rotunda upon the ampulla of the posterior semicircular canal was justified by symptoms and results of treatment.

A recent case of Burnett,¹ in which there was fracture of the base of the skull involving the temporal bone, illustrates the subject of hemorrhage into the ear. The patient had fallen and struck upon the head. Examination of the ear was made immediately, and there was no bleeding from the ear. Notes of the post-mortem appearances taken from the books of the Presbyterian Hospital were as follows: "Fracture of the petrous portion of the temporal bone. Blood in the tympanum. Because the fracture had not involved the annulus tympanicus, nor any part of the osseous boundary of the membrana tympani, nor the membrana itself, there had been no bleeding externally."

DISEASES DUE TO CHANGES IN THE ECONOMY.

It is interesting to note that certain temporary affections of the ear occurring from changes in the economy, such as the sudden anæmia of the brain in a fainting person, with consequent loss of function, give data by which we place these lesions where they belong, and presumably not in the labyrinth. It is well known that when we are fainting there first comes over the consciousness a feeling of partial dizziness, or of an ill-defined loss of the power of localizing one's self; next a loss of vision, all the outside world appearing to become clouded in darkness; then a roaring or ringing sound in the head, loss of hearing, and unconsciousness. These symptoms are in the order in which the blood leaves the parts of the brain where the centres for these sensations are located. The parietal region, being highest up, loses its blood first, next the cerebellum, with the optic lobes at the base of the brain, then the auditory centre, and lastly the highest centres of consciousness and volition, which retain their power longest because, normally needing less blood than is applied to the lower centres, they feel its absence least.

In similar conditions induced by drugs, quinine, salicylic acid, opium, etc., we may find certain disturbances in conditions which must be attributed with good reason to the vaso-motor changes at the centres rather than to direct effect upon the labyrinth. It is, of course, allowable to suppose that with such differences of tension, resulting in the increased or lessened blood-

¹ Communicated by private correspondence.

supply to the brain, there may be also more or less blood in the labyrinth. Yet here the hypothesis based upon the observations of Hasse, that every increased or diminished pressure of the cerebro-spinal fluid in the sub-arachnoid cavity will make itself felt by continuity through the sacculus and the ductus endolymphaticus, in the interior of the auditory apparatus, in the endolymphatic cavity, and upon the terminal filaments of the auditory nerve, and that thus may be explained the impairment of hearing for high notes when the pressure in the labyrinth is increased, is far more sensible.

Under the head of affections inducing morbid changes in the blood-supply to the cochlea, which will include anæmic or hyperæmic states, will need to be considered the direct or indirect results of these conditions. It is understood that the perfect functional activity of an organ presupposes a requisite amount of blood for the nourishment of the organ, and in the labyrinth for the preservation of its normal degree of tension. We may appreciate, then, the causes of such disturbances in function which are observed in diseases which produce anæmias or congestions of the head.

In cholera, typhoid fever, tuberculosis, and other debilitating and wasting diseases the impoverishment of the blood will prevent the labyrinth from receiving its normal nourishment, and its functions will be disturbed or interfered with. In the earlier stages of these diseases a hyperæmic condition may be noted, and pressure symptoms, tinnitus, and hyperæsthesia supervene. Patients will make complaint of hearing ringing sounds in the head or ears, and will be disturbed by objective sounds.

The diagnosis of an *anæmia* of the cochlea, when it alone is to be relied upon as explanatory of symptoms, will be made cautiously, and it is doubtful if an aurist would accept it to the exclusion of other more probable causes. It would be made, therefore, by this process of exclusion, and would be inferred as the condition if occurring in the course of debilitating diseases.

Diagnosis of *hyperæmia* follows in the same way: attention to the symptoms, with evidence from the attitude of the patient, makes a true inference possible. But this state of the labyrinth is so often associated with hyperæmic states of the head that the same remarks are here applicable as in anæmia. The value of the symptom of hyperæsthesia of the cochlear nerve should not be forgotten in the treatment of patients who are subjected to noises, and this will be again spoken of under affections of the internal ear which have been formerly described as "boiler-maker's deafness."

HYSTERICAL DEAFNESS.

Hysterical deafness, described by Charcot, observed among hysterical women, especially in communities where the fashion has been set by example, must be traced to disordered states of the auditory nerve at its centre, and, accompanied as it usually is with more extensive derangement of the nervous system (hemianæsthesia and contracted field of vision), demands

notice here simply because of mental association with diseases of the internal ear. The possibility of its occurrence, though extremely rare even in the older countries, makes its study necessary in cases of importance medico-legally, but it should not be considered, when present, as a lesion of the labyrinth alone.

Hysterical deafness is not a disease, only a symptom, as the name indicates. It is unilateral and affects either ear. The loss of hearing-power is complete, and may last for a few hours or days or remain more or less permanent. The ability of the patient to hold the function in abeyance is evidenced by the results of treatment with such means as must certainly act upon the imagination or will.

Treatment of this form of deafness must necessarily include that of the general nervous system, and would be directed to the removal of the causes which had produced the hysterical state.

THE INTERNAL EAR IN SYPHILIS.

Lesions of the internal ear in syphilis may be present in the earlier stages, may occur as later signs of infection, and may develop in the course of the hereditary form of the disease of the middle ear.

The anatomical change in the labyrinth in syphilis has been supposed, in recent cases, to be from the exudation of plastic material similar to that seen in syphilitic iritis. Examinations of the ear in such cases have not been made to confirm this, but the results of clinical experience would point to this, in all probability, as the cause of the symptoms. The disease begins with very marked subjective ringing noises, deafness soon follows, and there is usually a noticeable disturbance in the gait of the patient, while he complains of constant dizziness. The loss of hearing, when gradual, would suggest that the lesion is not confined to the labyrinth.

The diagnosis of labyrinthine syphilis can be given with certainty, according to Politzer, when the disturbance of hearing has developed rapidly, and when perception for sound through the bones of the head is wanting, taken with the presence of symptoms of secondary lesions of syphilis in other parts of the body, or when there is no doubt of its former presence from the history.

The prognosis of such cases is very unfavorable unless treatment is begun early and persevered in heroically. Treatment should be altogether general and anti-syphilitic, though it is advisable, in cases where this fails, to make use of subcutaneous injections of pilocarpine. In recent cases, where it may be supposed that there exists only a fluid transudation into the labyrinth, the pilocarpine should be tried before mercurials or iodides. These remarks apply to the use of this drug in these cases as in the treatment of the disease of the labyrinth in mumps. The importance of deciding the question of diagnosis is shown by the improvement following heroic treatment; and a case will serve as an example.

A patient whose general condition showed the presence of the syphilitic

poison, and who was the subject of exudative iritis, became suddenly deaf. No disease of the middle ear was to be made out, and tests proved affection of the auditory nerve in the labyrinth. Large doses of potassium iodide, sometimes as much as ten grammes a day, produced an intense psoriasis, followed by restoration of hearing within a period of about two months.

METASTASIS TO THE INTERNAL EAR IN MUMPS.

In parotitis, or mumps, a peculiar metastasis may occur by which the labyrinth becomes affected and total deafness results. The symptoms are those of pressure,—namely, ringing sounds, dizziness, and deafness. The patient seldom applies for treatment of this affection until some time has elapsed after recovery, and then, because of the organization of the plastic material, relief is seldom if ever obtained.

It is necessary to have this fact known, and the possible danger to the ear guarded against by the *treatment* of the parotitis. For this, full doses of pilocarpine should be given by the mouth, and protection and rest afforded by confinement in-doors. It is always wise to recommend treatment in all cases of labyrinthitis following mumps, even at long intervals after the occurrence of the lesion, for its use has been attended with improvement in many cases. Subcutaneous injections of pilocarpine, nitrate or hydrochlorate, in doses of from eight to fifteen drops of a four per cent. solution, for the adult, should be given, preferably at the home of the patient, in order to have its action continued for some hours. This may be kept up regularly for several weeks, daily, unless the patient shows signs of losing strength. It should be combined with tonic treatment in debilitated patients, and careful attention paid to its action upon the heart and general circulation in such subjects. As pilocarpine is a dangerous remedy, especially when used by injection, wisdom would indicate its careful use in all cases. Stimulation of the heart by the inhalation of ammonia is sometimes necessary in the after-treatment of the patient when passing through the chill which may accompany the full action of the drug.

PANOTITIS.

Panotitis is an inflammatory affection which may begin in the middle ear and extend to the labyrinth or may attack both of these portions of the ear at the same time. The course of this disease is very rapid, and ends in complete destruction of the functions of the organ, while its sequelæ may give rise to complications which produce lingering diseases, such as caries, necrosis, purulent inflammations, and other dangerous and fatal consequences of neglected bone diseases. The process sets in in the course of diseases in which a specific poison is present in the system, such as scarlatina or diphtheria.

The symptoms arising from so serious a disease are so severe, being usually preceded by chills attended with rise of bodily temperature, sometimes with marked convulsive movements and tendency to tetanic spasms,

that the physician is often led to mistake them for those of diseases of the brain. As so distressing a symptom as opisthotonos, even, may appear in the course of otitis media, when pressure from disturbed blood-vessels, hyperæmia, or exudations in the tympanum act upon the labyrinth by virtue of contiguity, it will not seem strange that the source of irritation may be overlooked, and treatment consequently fail to relieve. The results of observations made in such cases should cause physicians to remember the functions of the ear and the possibility that it may be the original site of a disease whose manifestations may be of so marked a character and at such distances from the seat of lesion. It is plainly a matter of importance for every one upon whom devolves the care of patients suffering from diseases in which infection by zymotic poisons begins in the throat, such as measles, scarlatina, or diphtheria, not only to diffuse the knowledge that in these diseases the ear is often diseased, but to insist that no measures should be neglected to prevent the spread of the infection to this organ. It has long been the custom, even among those whose intercourse with aurists should have given them some knowledge of the causes which promote the purulent infection of the tympanum and labyrinth, which not infrequently has ended in causing deaf-mutism in the child, to simply warn the parents against these results and take no pains to begin prophylactic treatment. If, then, one finds such negligence among those who do have these advantages, is it to be wondered at that the aurist, when consulted after the mischief has been done, hears the old-time remark, "when the child gets well again the running from the ears will stop," or the equally comforting one, "he will outgrow it"? One patient's hearing preserved, and the weary teaching of years as a deaf-mute saved, by prompt and judicious treatment, in every case threatened with otitis, will sufficiently reward one for learning how.

The examination of the nose, naso-pharynx, and tympanic cavities should be made. The treatment of inflammation when it has invaded the ear will depend upon its severity; for the acute stages leeching, cold compresses to the mastoid, cocainizing of the nose every four hours, followed by warm-water douchings or syringing of the auditory meatus with warm water, to which, in bad cases, disinfecting substances may be added, potassium permanganate or resorcin.

In nearly all cases where the inflammatory process is excessive, it may be correctly inferred that some previous disease of the naso-pharynx existed, such as hypertrophy of the mucous membrane or tonsillar hyperplasia (naso-pharyngitis) (hyperplasia tonsillæ pharyngææ.) With such complications only temporary improvement can be expected, and operative interference must be undertaken soon after convalescence, if the ears do not immediately improve. In urgent cases, though never during the exanthematous stage, means should be employed to preserve fair drainage through the nasal fossa to obtain nasal breathing. Irrigation of these passages with solutions of all kinds should be avoided, because of the certainty of causing infection of the tympanum through the Eustachian tube.

Further directions for local treatment must be sought in works on rhinology ; but the few rules for guidance above given will prevent, in most cases, the invasion of the labyrinth, and presumably shorten the course of the otitis.

PRIMARY ACUTE LABYRINTHITIS.

Primary acute labyrinthitis, described by Voltolini and by Politzer, is a very rare affection, and resembles in its onset and results the disease of the labyrinth described as panotitis. According to observers, the affection comes on in previously healthy subjects with fever, and great congestion of the face, followed by unconsciousness, delirium, and convulsions. These symptoms completely disappearing after some days, total deafness and staggering in the gait remain for a long time. It is not unlikely that many more cases of this character would be recorded if the resemblance between the symptoms of this disease and those of meningeal inflammations was not so marked. The difficulties attending its early recognition are such that careful inquiry should be at once instituted with a view of discovering the situation of the disease. If the patient is young and cannot give the subjective evidence necessary for a decision, or does not complain of pain in the ear or of ringing noises, but is deaf and dizzy, the ears should be examined, and if at all inflamed they should at once be treated to subdue the inflammatory process, which must be considered very serious.

Local depletion by means of several leeches placed in front of and behind the auricle, followed by applications of cold compresses, with the internal administration of opium or morphine to quiet the circulation and prevent exudation, should form the treatment, and every effort should be made to reduce the increased pressure upon the structures within the internal ear.

HYPERÆSTHESIA ACUSTICA.

Hyperæsthesia acustica, a peculiar over-sensitiveness of the cochlear nerve, is, fortunately, not a common permanent condition, but is occasionally observed in individuals whose nervous systems have become exhausted by worry, anxiety, or mental strain. Sounds, especially shrill noises, cause very unpleasant, painful sensations in the ear. It has been noticed that the highest tones which are capable of being produced cause these same feelings in normal ears. In this connection it is to be noted that the continual ringing of certain steel cylinders, made for testing the ability of patients to hear high tones, will often temporarily induce reflex neuralgic pains in the nerves of the teeth. It might be supposed that similar noises to which ears are constantly subjected in factories and machine-shops would induce permanent changes in the auditory nerves. Such, however, is never the case as long as the ears remain normally healthy, for the provisions of nature seem adequate to prevent these from taking place. A simple but homely illustration of this fact was given by the owner of a quartz-stamp-mill, to this effect : " There are twenty men employed at the crushers, and

the man who tends the noisiest one hears perfectly. The men's ears are never injured unless they are the subjects of catarrh."

AURAL VERTIGO.

The symptoms brought about by disturbances in the functions of the vestibular nerve from an increase in the normal amount of pressure within the apparatus formed by the semicircular canals above described are both subjective and objective. It is possible to induce these or similar symptoms by pressure upon the nerve in its course, or by irritating its fibres or its connections at its centre. These may be named as follows: sensations of dizziness (vertigo), as of the falling or rising of the body or head, of nausea, of vomiting, of loss of knowledge of one's location in space, of unsteadiness in gait, and disturbances of the muscles (choreic contractions, eclamptic seizures). It is not unusual for all the varieties of sensations of apparent motion to be simulated by affections of the different parts of the "space"-organ. It is noticed that patients with dizzy heads are unable to maintain a proper equilibrium when deprived of their eyesight by blindfolding, or when their eyes are closed. For the purpose of more fully understanding this important subject, attention is called to the conclusions of Ferrier, drawn from his own experiments and from the study of those of others. He explains that the power of maintaining equilibrium is derived from the education of the senses of touch and vision combined with the knowledge afforded the organism through the apparatus in the ear. One's eyes observe obstructions in the path, the feet feel the ground or floor, while the semicircular canals, as shown by Högyes, serve the double purpose of informing the brain of the position of the head and of regulating the movement of the muscles for the preservation of equilibrium.

Pressure upon the oval window is transmitted to the fluid in the membranous canals and causes an exaggeration of the normally present pressure to induce an effect which, if prolonged, is interpreted as a real condition. A single canal is thus irritated, for example, for an extended period, and soon the individual begins to feel what he describes as dizziness, with inclination to fall in one given direction, or, according to Ferrier, he may by attempting to counterbalance this impression actually tend to fall in a direction opposite to the one toward which the apparent sensation tended. For example, the right posterior canal being pressed upon, the patient might be noticed to stagger forward and to the left, instead of backward and to the right. The mechanical reasons for these phenomena have been explained, and the predisposing causes will now be considered. When in the course of a disease of the middle ear the atmospheric pressure upon the membrane is transmitted through the chain of ossicles to the labyrinth, the fluids within either accommodate themselves to the pressure, or transfer it unequally to the nervous filaments and give the impressions above referred to. These conditions are to be found in all varieties of disease of the ear in

which, from any cause, pressure can be made in excess of what is normally borne.

A mass of cerumen may act from the auditory canal, or serous fluid exuded into the tympanum may induce dizziness. Acute inflammation, by causing exudative products, also gives rise to dizziness in the same way. The rarer results of traumatism, hemorrhage into the tissues, blood-clots in the tympanum, pus, or sometimes masses of epithelium, figure as causes of this symptom. Cases like these are usually those in which nature has not had time to adjust or accommodate the parts of the ear to the new condition, and the sudden increase of pressure acts as described. In the chronic forms of disease of the middle ear, dizziness and staggering do not occur until very late in the progress of the disease, and then only by direct invasion of the labyrinth.

When one finds great retraction of the membrana, with indrawing of the malleus and presumably of the stapes, it is not usual to find labyrinthine symptoms present, except in cases which are described as boiler-maker's disease. Explanation is afforded by the gradual fixing of the chain of bones and the setting of the foot-plate of the stapes in such a way as to prevent the pressure from coming suddenly to produce dizziness. Cases in which the patient is noticeably unsteady in gait would naturally attract attention, and search for the cause should first be made at the ear. If sensations of dizziness are spoken of, questions to decide the apparent direction in which the head seems to move will usually elicit answers which will show what part of the labyrinth is affected, and its cause may be discovered by inspection of the auditory apparatus. These vertiginous symptoms may cause the sensations of motion forward, backward, from side to side, upward or downward, with combinations of these same to produce sensations in other different directions, as around and around as if in a horizontal plane, or downward and backward, and so forth.

These disturbances of the equilibrium or of the sense of normal location in space proceed sometimes from congestion or anæmia within the labyrinth, or may develop after effusions or exudations into the vestibule or ampullæ of the canals. There is probably a condition of the labyrinth which is akin to that which is the cause of glaucoma,—namely, an affection of the absorbents which interferes with the proper transudation of the fluids, so that the internal pressure is too great to allow the normal nutritive processes to go on. In consequence of this pressure, the same phenomena result as from the causes just named, and the patient is said to be dizzy, he staggers in his gait, has subjective ringing noises in the ears, and may be wholly deaf. This form of labyrinth-disease has not been recognized as a distinct affection, but presents such marked signs that the possibility of its presence should be considered in cases where, from the sudden access of the ringing noises, giddiness, and loss of hearing, it is desirable to make a differential diagnosis. The subjoined case is a representative one of this class.

In a man whose nervous system had become greatly overworked there

suddenly developed an affection of the ear, manifested by signs as follows. After hearing for several days a high-pitched ringing noise in the right ear, he became one morning very dizzy, so that his head seemed to be whirling around and around: he staggered sideways in walking, became nauseated, and at last vomited severely for some minutes. These attacks returned at shorter and shorter intervals, and were succeeded or accompanied by an irritation of the intestinal canal, until it was impossible for the patient to retain food, although he did not become sick enough to go to bed. The right ear was quite deaf, though its appearance was not such as to explain the above phenomena. Treatment locally gave such immediate relief to the labyrinthine pressure, which seemed to have been increased by a closed Eustachian tube and consequent driving inward of the chain of bones, that all the distressing symptoms disappeared. Under the internal use of pilocarpine, with occasional local treatment, the hearing returned to about one-half the normal amount.

Illustrating the connection between the labyrinth and the eyes, it was noticed that the corresponding eye was turned outward, and, though there was no double vision complained of, the irritation of the abducens muscle produced considerable asthenopia, and obliged the patient to give up writing or reading. Examination of the fundus of the eyes, several days after improvement began, revealed no changes except stasis in the eye on the opposite side.

From whatever source the pressure may come, the resulting symptoms are always similar, and these phenomena should always receive attention, especially when occurring in the following order: ringing (in the head or ears), dizziness, reeling, nausea, vomiting. This complex of symptoms always indicates a labyrinth-lesion which may be functional or organic, and should be studied apart from peripheral disturbances elsewhere. For example, in a patient subject to gastric disorders the stomach must not always be interrogated first, especially if the nausea is of infrequent occurrence and appears independently, not being influenced by digestive processes. It is not to be inferred from this, however, that the labyrinthine vertigo accompanied with gastric disorders may not be caused by derangements of the stomach, and could be cured by treatment of the primary disease; but when patients complain of having dizzy heads and are also deaf, the cause must be sought in the ear.

RELATIONSHIP OF THE INTERNAL EAR AND THE EYE.

Clinical observations which plainly show the relations existing between the two principal organs of special sense constituting the optical and the acoustical apparatus were made by the writer and recorded in an article published in 1889. Speaking with greater precision of this relationship of the ear to the eye, it is proper to refer to that which, within the labyrinth, constitutes a peripheral apparatus provided to apprise one of a sense of location in space, having also a regulating function over the muscles

of the eye, and probably over all the muscles of the body for the preservation of equilibrium. From the many experiments upon animals and from pathological data it has been learned that certain movements of the head and eyes take place when the semicircular canals are irritated or partially destroyed; and this, although Politzer and Lucae were on record as discrediting the information obtained from the observations, because they had found that in cases where the canals were entirely wanting, or were entirely destroyed by disease, no symptoms such as are recognized as caused by lesions of the canals were present. They apparently forgot that these canals formed only a peripheral organ, and that when destroyed the individual possessed no means of learning of false positions in which he might place his head, while he still retained the centre within the brain capable of being educated by sight and the tactile sense. That all patients suffering with dizzy heads have a varying amount of disturbance of the external recti muscles, ought now to be an accepted fact. The term used by oculists to denote variation from a vertical line and applicable in these cases is exophoria, which is attended with such a condition of the external recti muscles, which are supplied with the sixth (abducens) nerve, as to cause divergence to a degree easily noticeable, or to attract attention when convergence of the globes is attempted.

In certain very marked cases the abducens becomes so powerfully irritated that it is impossible for the interni to act to produce convergence. The first symptom which would cause the patient to apply for treatment would undoubtedly be the diplopia, or double vision; and it would be interesting, were it possible to do so, to collect statistics proving the relative frequency of unsteadiness of gait and the coincidence of diplopia in such common cases as those of alcoholic intoxication.

This condition of the ocular muscles known as exophoria, which may be a cause of diplopia or of more or less permanent asthenopia, is explainable by study of the nervous connections of the sixth and eighth nerves within the encephalon. We have tried to find a theoretical space-centre located at some point in the cerebrum. Whether this is the case and it can eventually be found, must be decided by experiments having this object alone in view. The researches of physicists and medical men during the last two decades, when more fully studied by those who ought to be most interested therein,—namely, ophthalmologists and aurists,—would undoubtedly give valuable information upon all the diseases in which disturbances of the function of equilibrium are to be observed. Attempts have been made by neurologists to obtain information from aurists regarding the condition of the ear in *ataxia (tabes)*, which have necessarily resulted in furnishing only negative evidence, plainly because the aurist has no means, when confined to his specialty, of examining the peripheral space-organ. And here science must stop unless the oculist is willing to study the ear while the aurist investigates the eye. The pertinent suggestion can, however, be made by the aurist that it will be possible to obtain satisfactory evidence of the amount of disturb-

ance of the ocular muscles by irritation at the extremities of the vestibular nerve (from causes lying without or within the labyrinth, as previously stated in this article) only by the use of instruments of precision.

A prominent oculist of New York City has lately invented what he has termed a phorimeter, or instrument for the determination, by the use of prisms, of the relative amount of deviation of the muscles of the eye from a normal (empirical) standard. This instrument ought not to be condemned at once as useless, because its invention has opened the way in the field of scientific experimental inquiry into these problems, but the manner of its use precludes the possibility of accurate results in all hands. To decide when the visual axes of eyes are normally placed, it is necessary to decide when their horizontal axes are on the same plane, and to maintain them in this plane when tests are made. A very considerable amount of exophoria may pass unnoticed, or conversely a large degree of divergence may be supposed to exist, unless this necessary precaution is first observed. In the investigations made by the writer through the kindness of an oculist friend, this determination of the normal horizontal and vertical planes was made by means of two small levels fixed upon standards attached to a frame similar to a hatter's brass measuring-band. By looking at the air-bubble in a level placed over the eyes it was easy to bring the horizontal axis of the eyes to correspond to the horizontal plane of the head, when once this plane had been decided upon. In like manner the head was retained in proper position by adjusting it to correspond with the plane of a level placed at the side of the head. When the head and eyes have been properly adjusted, the prism test may be made, preferably with colored lights, and the presence or absence of reflex irritation decided upon. The amount of variation from normal can also be accurately determined.

The explanation of the phenomena of reflex stimulation of the sixth nerve, and consequent exophoria, latent or manifest, lies, probably, in the anatomical relationship sustained by the two nerves,—the vestibular branch of the auditory and the abducens. Careful study of the writings of various authorities has made it possible to come to the following conclusion, which is based upon the decision of Högyes, to wit, that "the centre of this nervous apparatus lies in the parietal lobe of the brain and in the medulla oblongata, between the upper branch of the acusticus and the oculo-motor nucleus. A centrifugal tract is formed by the oculo-motor nerves with the eye-muscles, while the vestibular branches of the auditory nerves with the ampullæ and nerves of the crista acustica form a centripetal tract."

Ferrier places a motor area of the eye-muscles in the frontal lobes. Högyes places the centre for the vestibular nerve in the middle lobe of the brain in the parietal region. Sections of the medulla oblongata and lower parts of the cerebrum and cerebellum made by Freud give nerve-filaments from the eighth nerve passing close to, and perhaps connecting with, the nucleus of the oculo-motor nerve.

GENERAL CHOREA.

As it is proved that the muscles of the eye are regulated by the apparatus within the ear which probably controls their movements and those of other muscles for the maintenance of equilibrium, it would be fair to suppose it possible to find that derangement of these functions produced by pathological changes in the ear would provoke marked disturbances in the muscular system, which might simulate or develop into chronic diseases of the muscular system in which incoördination of movements is a symptom, such as chorea. The following case is given as illustrative.

A girl of ten years was noticed to have twitchings of the muscles of the whole left side of the body, and when walking she constantly turned towards the right. These choreic movements were constant, but not excessive, and, while involuntary, the muscular contractions could be restrained for a few minutes by an effort of the will. This patient was seen, six weeks after the appearance of the disease, by the writer, in consultation with a neurologist to whom she had been brought for treatment. The condition of the left ear was as follows: membrana slightly opaque, very much depressed; mucous membrane of tympanum slightly congested, giving it a pinkish hue. Naso-pharynx filled with vegetations (hyperplasia of pharyngeal tonsils). Nasal passages free. Right ear had been previously inflamed, and the membrana and malleus were absent. Membrane of tympanum clear and normal. The tympanum was therefore dry. Treatment directed to the opening of the closed Eustachian tube on the left side immediately resulted in relieving the labyrinthine pressure, and caused the child to walk straight. In a few days, and after the middle ear became normal consequent upon the removal of the naso-pharyngeal growths, the choreic symptoms entirely disappeared, and did not return.

MALFORMATIONS OF THE INTERNAL EAR.

Congenital defects or arrest of development may be found in the labyrinth coincident with malformations of the external ear. These malformations consist, as quoted by Politzer, in complete absence of the labyrinth, absence of one or all of the semicircular canals, rudimentary development of the same, absence of the vestibule and cochlea, absence of the labyrinth or imperfect development of the striæ acusticæ and of the nucleus of the auditory nerve, with other modifications or defects.

In unilateral absence of the external and middle ears, the state of the labyrinth on the same side can be ascertained in patients able to give answers to inquiries, by examinations with the tuning-fork. When the vibrations of the fork on the vertex are better perceived by the malformed ear, the development of the labyrinth may be supposed to be normal; when, on the other hand, the tuning-fork is heard only by the normal ear, it is probable that there is a defective development of the internal ear on the malformed side.

PART II.

ACOUSTIC AID AND AURAL HYGIENE OF THE VERY DEAF, PARTIAL MUTES, AND DEAF-MUTES.

THE consequences entailed upon the young by the various diseases which produce deafness, and that of so high a grade as to cause the child to remain dumb or to lose the faculty of speech acquired during the period when able to hear, are so lasting and serious that it should be the duty of every medical observer to detect any loss of hearing and apprise the parents of this at once. It is oftentimes ignorance of the child's condition which allows the parents to wonder why a child is backward in learning to talk, and which causes the delay in obtaining treatment, which is too frequently asked for too late.

It is not always an easy task to decide whether a child is deaf or simply inattentive. The usual means employed to detect hearing fail because incautiously or wrongly made use of. It is possible for the deaf child, if bright and fairly intelligent, to observe with his eyes any sign or motion made by the one testing the hearing, and for a wrong conclusion to be reached and the child considered to have hearing when really deaf for ordinary sounds.

Among these tests which give inaccurate results are such as the clapping of one's hands behind the head, stamping upon the floor, and shouting into the ears. With all of these the child's educated sense of touch or sensitiveness to aërial impressions causes him to turn almost as quickly as if he heard the noise. So, too, with all sounds whose production requires movements of the hands, like striking a bell with a hammer. Deaf children will feel even the light current of air made by the moving hand. While older children can make known their powers to detect sounds, they often deceive themselves and their observers by improperly interpreting their sensations. The child is sometimes very anxious to be able to say that he hears the vibrations, when in reality he feels them.

It would seem an easy matter to decide at once whether the year-old baby hears or does not hear, but this is far more difficult than one would suspect. The most certain method, and one very easily tried, is that of striking a finger-bowl sharply with a key when the child's attention is attracted to some object away from the observer. Most children will turn their heads at once to the sharp high-pitched sound, for it is unusual to find any deaf-mutes so deaf that this sound is lost. One should not be satisfied with this trial alone, but should try lower-pitched tones, such as the voice furnishes. If the child responds when called by name from a considerable distance across a large room, or from an adjoining room, it will suffice to prove the presence of hearing.

The normal amount of hearing, or the quality of the tests, need not be

regarded here, for more evident signs will have directed attention to the ears, and, if the rule which all aurists lay down were followed, deaf-mutism would be avoided in such cases. Any disease of the ear demands immediate treatment, and the old fallacy that nature will cure it ought to have been given up long ago. When a child shows by inattention, stupidity, or apparent heedlessness that he has become deaf, or when, during the course of exanthematous diseases, he suddenly loses his hearing, his physician should, as soon as possible, see that the disease which causes these symptoms be discovered and treated.

It is not so much the fault of the specialist that the cases of mutism from loss of the function of hearing continue to furnish schools with pupils for special instruction, as it is of the cruel neglect which parents are guilty of, and for which they are not always themselves entirely responsible.

All deaf-mute children should be carefully examined for the cause of the deafness. Search must be made in all parts of the auditory apparatus and its connections in the nose and naso-pharynx. Whenever the history of some serious brain-disease is given, even if one of those in which it may be surmised that exudation products of inflammation have pressed upon and destroyed the function of the auditory nerve, this examination must always be made. It is the practice of some to take many things for granted in the examination of deaf-mutes, and very recent experiences in cases which have come under observation make it the more needful to emphasize these directions.

The writer has had occasion to pass judgment as to the treatment of a patient in whom even a little improvement in hearing warranted an effort, because of serious defects in his eyes, which had already obliged the patient to live in an institution for the blind. An attack of cerebro-spinal meningitis, so called, was supposed to have been the cause of the loss of sight and of the hearing of one ear. The prognosis had been made very unfavorably, and the patient turned away untreated. Having persisted, however, in seeking for aid, it was learned from his history that the deafness, which was only partial, came on eight years after convalescence from the fever. Local treatment restored a normal amount of hearing, and the inference was very natural that the disease was entirely in the middle ear, and not labyrinthine or central.

Again, in a child in whom the history of muteness and the negative signs of disease in the middle ear gave conclusive evidence of labyrinthine lesion, the removal of adenoid tissue from the naso-pharynx and continued local treatment of the nasal passages and Eustachian tube restored hearing and improvement in speech and vocabulary.

While the cases of labyrinthine disease causing deaf-mutism are not infrequent, and if overlooked during their earlier stages become incurable, it will be none the less the duty of aurists, and of all medical men as well, to place the causation and treatment of diseases of the ear, which have deaf-mutism as a symptom, among the list of remedial affections of this organ.

There can be little doubt that many deaf-mutes might have had a useful amount of hearing preserved or restored to them had an early diagnosis and thorough treatment been given them. Boucheron long ago called attention to the usefulness of local treatment in many cases of so-called congenital deaf-mutism, but really of acquired middle-ear disease, and many patients have been saved from becoming mutes by persistence in the use of local means and remedies where formerly they would have been recommended to await the coming of a suitable age or sent to the deaf-mute school. It is probable that the continuance of any disease of the ears which prevents for a considerable period the hearing, through the air, of a patient's own voice during the early months or years of life, will always have as a result that loss of the faculty of speech which naturally brings mutism. When children have once learned to speak and have suddenly become deprived of their power of hearing, they may lose the faculty of speech also. When, too, by force of circumstances, young children find that the use of speech is of no service to them for communication with parents who are deaf themselves, these may, by falling into a habit of preferring signs, neglect to learn, and become mute. If to these circumstantial causes are added a defect in hearing, and, presumably, in parents deaf from early years, or not well instructed in the use of their voices, imperfect enunciation, the necessary factors are provided for the making of a deaf-mute, independently of the hereditary influences always working in such cases.

It is often supposed that deaf-mutes are deaf, and a conclusion is arrived at, from this supposition, that the loss of hearing was directly traceable to disease of the nerve of hearing in the labyrinth or within the cranium. Instead of being deaf, most deaf-mutes hear, and a fair percentage hear quite well. This leads to a different inference, and—though it is not unlikely that in the few cases where the highest tones only are responded to, certain rods of the organ of Corti have escaped injury by disease—probably the correct inference, namely, that other causes, to be discovered outside the labyrinth, have operated to produce deaf-mutism.

The most common causes for the loss of the auditory function are those which tend to produce and keep up congestions in the naso-pharyngeal space, and consequent derangement of the sound-conducting apparatus. Foremost among these causes is the almost barbaric treatment of infants by frequent bathings. Many mothers allow their children to be entirely stripped of clothing and washed all over every morning. They studiously avoid bathing the head, and this exposure of a large surface and the chilling shock upon the superficial blood-vessels drive the blood into the nose and ears as well by direct influence as by a reflex irritation through the sympathetic system of nerves. The more delicate children are unable to recover from this shock in time to be prepared to resist the next one. To speak more exactly, the blood-vessels within the nose and ears become so filled that they have not completely contracted before another shock is given, and in process of time they become paralyzed, and hypertrophies with actual increase in

tissue-formation develop, so that the nasal passages and the tympanic mucous membrane and other normally-delicate tissues grow very thick.

One cannot enter fully into the enumeration of causes and their effects likely to produce such impairment of the functions of the ear as may lead to deafness and consequent mutism ; but a brief classification of diseases may be made, as follows : diseases of the middle ear attended with thickening of the tissues therein (*otitis media catarrhalis mucosa chronica*), of the middle ear with destructive processes (*otitis media suppurativa*), of the middle ear with mechanical affections of the joints between the ossicles, of the labyrinth (*primary labyrinthitis*), of the labyrinth with suppuration (*panotitis*), and of the labyrinth by extension from within the cranium (*cerebro-spinal meningitis*).

The relationship of disease of the ear to loss of speech is such that it is probable that in the great majority of cases the auditory apparatus is affected subsequent to birth, and that even in those cases which statistics present as congenital the early examination of the ears would have given definite evidence of disease. It is a known fact among aurists that babies' ears are particularly hard to look into, on account of the relatively small size of the external canals and the difficulty of retaining the head in position while a view of the membrana is obtained. Unless an outward sign of disease is given by the presence of excoriations about the meatus or by purulent fluids exuding therefrom, and as in some instances even these may be overlooked, there is no certain knowledge obtainable regarding the time of commencement of the deafness. If the child has spoken a few words, it ought to be supposed that hearing was once present, for it is very unusual to find children who speak from whose history it will not be possible by careful searching to discover the symptoms which would show the affection of the ear which had caused the deafness.

The question as to the probability of deaf children always being born deaf is certainly to be decided negatively. Some children may be born deaf, and an accurate decision as to what children are congenitally deaf, and why they were so, can be arrived at only by a comparison of statistics compiled by reliable observers. The hereditary tendencies among children born of deaf parents have been pointed out by Professor Graham Bell, who presents the views of a careful observer. He believes that a natural tendency to disease is increased among their offspring by the intermarriage of deaf-mutes, and has forcibly illustrated his convictions by urging deaf-mutes to seek hearing partners, in order that their descendants may not be born deaf or inherit a marked tendency to deafness.

The laws governing hereditary tendencies in general must have the same bearing upon the subject of inherited diseases of the ear as upon the other known phenomena of transmission from parent to offspring, and the tendency to the early development of conditions favorable to the production of ear-diseases should claim attention from physicians.

It remains an undecided question as to whether the loss of the function

of hearing can be transmitted. The variety of causes producing this symptom of deafness is so great, and the possibility of both parents having complete atrophy of the ear and the brain-cells at the centres of audition so unlikely, that, theoretically, it would always be safe to allow of the intermarriage of deaf people without necessarily anticipating congenital deafness among the children. Practically there is not sufficient evidence to warrant us in doing more than warning the deaf against this probable danger. There are many reasons why parents affected with ear-diseases which have brought on deafness, such as catarrhal inflammations, bear children in whom strong hereditary influences may assist in causing the development of similar diseases when started by exposure to cold or by any of the causes which are known to bring on inflammation of the mucous membrane.

A more complete knowledge of all these causes and a thorough understanding of the relation of cause and effect will quite likely place us in a more favorable position to judge, while more information may enable us to go even beyond this and prevent or restrain the action of these causes.

An examination of the conditions of the auditory apparatus, together with the determination of the presence or absence of hearing, was made by the writer in one hundred and thirty-six cases among scholars at the Clarke Institution for Deaf-Mutes, at Northampton, Massachusetts, and at the Horace Mann School, in Boston, in November, 1891. These examinations of the ears were made without reference to the history of the cases, and with the idea of discovering a cause, if possible, for the deafness which had caused mutism.

The patients' ears were looked at with mirror and speculum, and the diagnosis of conditions found recorded before any knowledge of the supposed cause or the previous history was given the examiner. For this reason it may be presumed that deductions made from these diagnoses will be as accurate as possible. The reparative processes which go on very rapidly in the ear with marked changes from those to be found while a disease is progressing would explain discrepancies between the histories and the diagnosis as obtained by examination several years after the occurrence of the diseases said to have furnished the histories.

In many instances where the history of a case would point to a disease of the ear, and a proper record of such symptoms as would serve to decide its actual location is wanting, one may find no lesion of the ear to explain the defect in hearing. In such cases it is sometimes possible to make a diagnosis by calling to mind the usual train of symptoms likely to have been present, and comparing it with the history. For example, it seemed more than likely in many cases where the ears were found normal in appearance that there had been a labyrinthitis, with or without external discharges of pus.

There was history of the sudden onset of a serious affection of the head, attended with apparent or actual loss of consciousness, great prostration, convulsive movements, perhaps so severe as to cause burrowing of the head

into the pillow, or even opisthotonos, followed during convalescence by marked disturbances in gait in walking, with tendency to fall or lose the balance, especially when meeting obstructions. If children who have once walked have been thus affected, they usually stagger about a room, and always fall when trying to avoid striking against the articles of furniture. These symptoms may, of course, accompany any disease of the meninges in which exudations may press upon the auditory nerve in its tract, and many deaf-mutes become such during epidemics of cerebro-spinal meningitis. As, however, all the above-named symptoms may be observed where only suppurative inflammations of the tympanum of short duration have been noted, though the convalescence was rapid and not attended with the more serious disorders, it is not necessary to suppose that every case of deaf-mutism with normal membranæ tympanorum was certainly from meningeal exudation. The conclusions arrived at by the study of the cases above referred to cannot be definite in more than two particulars,—namely, that deaf-mutes usually have some hearing-power, and that disease usually causes the deafness. From these facts we may learn that children are rarely born deaf, though they may acquire disease to produce mutism within the first years of life.

Out of one hundred and thirty-six cases, twenty-eight were said to have been, or were supposed to have been, born deaf, and of these there were thirteen cases of evident disease of the ear. Of the remaining one hundred and eight cases there was some other disease given as a cause. The examination showed disease of the ears in ninety-four.

It is one of the strange anomalies of human nature that the sympathetic instinct of the mind is given opportunity to show itself most frequently when the object of that sympathy is something visible or tangible. Blindness when accompanied with closed eyelids at once attracts attention and elicits a kindly remark or a look of pity. On the other hand, deaf ears appeal to the mind only as objects for ridicule and contempt, and probably because the lesions producing the defect are not attended with outward visible signs and because deafness may be mistaken for or simulated by mental inactivity.

We easily get out of patience if our speech is incorrectly heard or interpreted, and we are very apt to lose our tempers when we find it necessary to repeat for those who are defective in hearing. These impressions acting for generations upon mankind have produced such sentiments among them in regard to deafness that it has become a reproach to be thus afflicted. When, therefore, the deaf person seeks for artificial aids to improve or restore his hearing, he naturally avoids anything which will tell the story of his affliction by its conspicuous size or peculiar form.

With the exception of the various forms of artificial drum-membranes applied by the aurist, there are no instruments, small enough to be invisible, of much, if any, service to the deaf.

It is to be understood that all instruments made for the purpose of

increasing the hearing-power by collecting and conducting sound-waves to the ear are therefore of a conspicuous size.

It would not be expedient were it possible to enter into a description of the various forms of instruments intended by their inventors for the use of the deaf. It should be premised that the deaf person when attempting to make a choice of one of these instruments should decide to accept only such an instrument as would improve the hearing for the ordinary conversational tones of the voice. The want of scientific knowledge in preparing instruments, as well as in the choice of them, has made it very difficult for the aurist to recommend artificial aids or to prescribe particular forms for individual uses.

The reason of this is most apparent when the study of acoustics has made this subject of magnification of sound understood. The very deaf may be supposed usually to have some disease of the middle ear which causes obstruction to the sound-waves. In such cases the impairment of the hearing being due to a fixation or setting of the conducting apparatus, it is evident that only sounds of great intensity will cause the ossicles to transmit the vibrations. We therefore find that it is necessary to apply the mouth directly to the end of the instrument or very near to it in order to preserve enough power in the voice to make the patient hear. When, too, loud shouts are made, the patient's ear is suddenly shocked, and confusion of hearing results.

For those persons not very deaf and with enough hearing-power to enable them to hear loud conversation, the case is different; and it is to this class that ear-trumpets should be recommended. A little added hearing-power would, with many patients, be of such assistance that the constant strain which fatigues the ear so quickly and renders it even more deaf would be removed, while the comfort and satisfaction derived therefrom would react favorably upon the individual and his friends as well.

The importance of this is not appreciated by aurists as it should be, partly, perhaps, from fear that the impression might be given that when artificial aids are advised the prognosis is no longer favorable and the case likely to be considered incurable. This fear, together with the general antipathy to the use of instruments, continues to prevent encouragement in their use, and may effectively hinder the scientific study of very interesting acoustical phenomena for the development of this department of otological research. To paraphrase the words of an eminent writer, "if it were not that the science of acoustics is one of the least perfect branches of human knowledge, and its practical application certainly the least understood, it would be easy to explain the principles on which perfect ear-trumpets should be made."

Because so little is known regarding the kind of deafness which is a symptom of so many and so varied diseases of the ear, it is not possible to speak with any degree of certainty as to what the best form of instrument to be recommended is, and, indeed, the more knowledge obtained of the

deafness the more difficulties are presented in overcoming the same. It is frequently observed that the ordinary instrumental tests for the determination of hearing fail entirely to correspond with the tests with the voice; for example, a patient very deaf for the tones of a watch is able to hear conversation quite well, or a patient who finds it difficult to hear the ordinary tones of the voice can hear the watch ticking at a considerable distance. These same discrepancies obtain with Politzer's acoumeter.

When aurists have made a standard for properly measuring the grades of deafness and decided for individual cases the pitch and quality of the sounds to be restored, the instrument-maker can then be correctly informed as to the sort of instrument to be furnished the deaf. All instruments which reinforce the lower tones of the musical scale are suitable for the deaf, who have lost, as a rule, many of these tones. Those instruments which bring to the ear the largest number of tones of varying wave-lengths are the most useful. It is to be stated, when speaking of instruments to aid the deaf, that up to the present time no instrument has been invented and put upon the market which is of enough value as an acoustic aid to deserve recommendation from aurists for all cases.

A choice from the many kinds and forms may be made for each deaf patient, which should be tried both by the aurist and by the patient. The character of the deafness, whether consisting of a diminution in the power of hearing for all sounds or of partial loss for certain tones, should be determined by the aurist. To a certain extent, the deaf patient who finds it impossible to hear loud conversation at ordinary speaking-distances will be aided by the instruments which are of service to all deaf persons. Practically, however, all deaf persons dependent upon lip-reading can be assisted only by instruments which bring the voice in direct communication with the ear. They may find that certain instruments serve better than others for special uses, as for listening to certain qualities of voice or for distinguishing certain tones in music; but for the ordinary daily uses, for all voices, the instruments called conversation-tubes are most in favor.

Instruments for the deaf are of two kinds: those which are modelled on the principle of collecting and reflecting the sound-waves through the air in the auditory canal to the drum-membrane, and those which are intended to collect and transmit vibrations through the bones of the head to the auditory apparatus.

We have stated it as an axiom that all small inconspicuous devices, except such artificial membranes as may be carefully adjusted by aurists, are of little or no use to the deaf.

A few principles for guidance in the choice of proper instruments will be here given. The size, shape, and length of each tube, as well as the condition of its interior surfaces, its mouth-piece and ear-tip, are to be first examined and compared with those of all the kinds obtainable. The size of the internal bore of a tube is of prime importance, as every aurist knows by experience with his "otoscope," which is usually made of flexible (rubber)

tubing fitted at each end with ear-tips. A comparison of tubes of different calibre, though fitted with the same ear-tips and of equal length, will quickly show that tubes are resonators for the various tones, and that the same sounds heard through the different tubes appear much varied in character. Cone-shaped tubes without breaks or seams within are best formed to convey the sound-waves to the ear. Cylindrical tubes should have mouth-pieces which are cup-shaped, *i.e.*, ellipsoid or parabolic, and ear-tips with bores of the same calibre as the diameter of the tubing.

It is customary for makers to form their tubes of spirally-twisted springs, which are then covered with braided silk or cotton threads in order to retain flexibility, and it is probable that if the suitable size and length could be obtained for each patient, the reflecting surfaces of this wire, which usually obstruct the sound-waves somewhat, would not produce a noticeable impairment of the power.

Of the score of forms of ear-trumpets offered for the use of the deaf by surgical instrument dealers, but three or four appear to have been constructed with a view to secure the best results with the least expenditure of material. In order to meet a demand for small instruments, makers have been led to sacrifice utility for size, and on this account have fallen into error.

The ear-trumpets which give the most satisfaction are those made on proper acoustical principles without reference to size. These combine the reflecting parabola with the cone-shaped conducting tubes. All the ordinary ear-trumpets consist of large horns with wide extremities tapering with more or less varied curves or with frusta of cones to the small ends, which are fitted with ear-tips intended to fit into the auditory canal.

A cone-shaped tube tapering gradually to a point, and with one of its sides partially cut away, is the best kind of instrument for the use of those partially deaf. The cut in the side, as now made, is of service in forming shorter columns of air in the tube, which serve as resonators for tones of high pitch (partials of tones), thus giving a more serviceable instrument than one formed from a plain cone.

Instruments ought, theoretically, to have their usefulness increased many-fold as aids in teaching children whose defective hearing prevents instruction in the ordinary way. Practically, however, but one instrument, devised some years ago by Sexton, of New York, has been found of value for this purpose. So valuable an instrument as this merits description. A double set of flexible tubes are fitted with ear-tips, after the manner of the binaural stethoscope, and pass from the arms of the instrument to two mouth-pieces. When in use, the teacher holding one of the mouth-pieces speaks directly into it, while the scholar holding the other mouth-piece repeats into it sounds which were conveyed to his ears (through the tubing), and is thus enabled to hear his own voice. By these means the child learns to give correct sounds and the proper intonation to his voice. This instrument is invaluable as a means to be employed to stimulate into action the auditory nerve whose functions have become impaired by disease.

Those instruments invented to convey sounds to the ear through the bones of the head and given names suggestive of their uses, such as audiophone, dentaphone, and so forth, have proved of service in cases where the sound-conduction by bone has been very good. Their advantages as scientific instruments over those easily constructed from sheets of stiff cardboard or Japanese fans are not such, however, as to encourage their use.

Those not familiar with this method of communicating with the deaf may obtain an ordinary rice-paper fan and fold a small piece of sheet tin over the edge opposite the handle, to protect the paper from moisture. Thus prepared, the fan is to be held by the teeth of the patient, while the handle is firmly held between the fingers, which should be used to bend the instrument to make the fibres of the paper taut. In some instances where this simple means has been employed great improvement in hearing has been obtained. The fact, however, that many patients do not easily understand spoken words when hearing through these instruments, and are obliged to learn to do so, would make it advisable for the aurist to recommend them for use only by those patients in whom other tests have shown good hearing-power by bone-conduction.

OCULAR LESIONS IN AURAL DISEASES, AND COINCIDENT OCULAR AND AU- RAL DISORDERS IN SYSTEMIC DIS- TURBANCES.

BY CHARLES A. OLIVER, A.M., M.D.,

One of the Attending Surgeons, Wills' Eye Hospital, and one of the Ophthalmic Surgeons
to the Presbyterian Hospital, Philadelphia,

AND

ARTHUR H. CLEVELAND, B.S., M.D.,

Clinical Assistant, Nose and Throat Department, Philadelphia Polyclinic.

ALTHOUGH it is now acknowledged that there is no reason for the organs of sight and hearing to be linked together scientifically as they have been for so many years popularly, yet, as not only is there a direct anatomical communication by which disease is carried from one to the other, but as they are also both peripheral sense-organs, each, as it were, physiologically responsive to a correlated form of stimulation, and thus make manifest their disturbances in relatively identical ways, it has been thought wise to place such a chapter as this before those who are most interested in these two branches of medical study, so that correlated symptoms may be advantageously used in the diagnosis of neighboring local disorder, and in the detection of causative systemic disturbance.

The subject-matter has been divided into three clinically distinct portions:

I. Ocular lesions dependent upon disturbances originating in the auditory apparatus.

II. Auditory lesions dependent upon disturbances taking place primarily in the visual apparatus.

III. Coincident ophthalmic and aural lesions arising from other causes.

I. OCULAR LESIONS DEPENDENT UPON DISTURBANCES ORIGINATING IN THE AUDITORY APPARATUS.

Of eye-symptoms associated with aural disease, optic neuritis is undoubtedly the most frequent and the most important. It is to be sought for in all cases of suppurative disease of the internal ear, and is to be con-

sidered positive evidence that the inflammatory process has invaded the cranial cavity. In beginning any consideration of the symptoms of intra-cranial lesions it will be well to give a rough outline classification of the lesions possible as a sequel to ear-disease, and from that classification study in detail, under each head, the meagre statistics obtainable. These lesions are in the main abscess, meningitis, and sinus phlebitis. Some indication of the relative frequency of the occurrence of these different conditions may be obtained from the following figures.¹

Bürkner, in his compilation of the observations of sixteen authors during the years 1881, 1882, 1883, and 1886, records eight hundred and sixty-four cases of suppurative otitis media, but finds only eleven cases of death from intra-cranial complications due to this disorder. The direct causes of these were: meningitis, six cases; cerebral abscess, two cases; cerebellar abscess, one case; sinus phlebitis, one; and pyæmia, one. Mr. Barker² gives an analysis of forty-four fatal cases collected from the reports of three of the leading London hospitals during the twelve years 1877 to 1888 inclusive. In these cases the probable immediate cause of death is given as meningitis in twenty, pyæmia in fourteen, cerebral abscess in four, cerebellar abscess in five, and phlebitis of the lateral sinus in one.

Poulsen,³ in the record of ten thousand one hundred and fifty-nine post-mortems, finds that the cause of death in but twenty-eight cases was cerebral disease following purulent otitis media. In twelve of these the immediate factor producing death was cerebral abscess, in eight it was meningitis, and in the remaining eight it was a sinus thrombosis. Combining the figures given by the three observers just quoted, we obtain the following table:

Immediate Cause of Death.	Bürkner.	Barker.	Poulsen.	Total.
Meningitis	6	20	8	34
Cerebral abscess	2	4	12	18
Cerebellar abscess	1	5		6
Sinus phlebitis	1	1	8	10
Pyæmia	1	14		15
Total	11	44	28	83

This table contains all the recorded intra-cranial lesions resulting from the extension of inflammation from the ear. Thrombosis of the sinuses has been included under the head of sinus phlebitis. Regrouping these under the heads proposed above, we find that abscess was the accredited cause in twenty-four of the cases, meningitis in thirty-four, sinus phlebitis in ten, and pyæmia in fifteen.

¹ When we consider that an absolute knowledge of any of these conditions can be obtained only from the post-mortem table, and that but a very small percentage, even of the cases in which death is directly due to the intra-cranial lesion, furnish us with data, we can form some idea of the untrustworthiness of statistics.

² Hunterian Lecture, 1889.

³ Nordisk Medicinsk Arkiv, Nos. 8, 15, 1891.

Pitt¹ reports that in a total of fifty-seven post-mortems made during the twenty years ending in 1890 upon patients dying from complications arising from ear-disease, twenty-two were cases of thrombosis of the lateral sinuses. As an outcome of these intra-cranial disturbances, the majority of writers consider that pyæmia arising in connection with disease of the ear is a direct sequence of thrombosis or phlebitis of the sinuses. Barker,² on the contrary, says that "pyæmia may be associated with any of the intra-cranial conditions, or may start from suppuration in the middle ear without any mischief at all within the skull."

The presence of optic neuritis during the progress of middle-ear disease may, as a rule, be accepted as evidence of one of the foregoing conditions. On the other hand, its absence will not warrant the exclusion of intra-cranial complications. As bearing upon its relative frequency in the different intra-cranial lesions, the following table by Edmunds³ is of value :

Disease.	No Optic Neuritis.	Single Optic Neuritis.	Double Optic Neuritis.	Total.
Thrombosis.	1		3	4
Meningitis		1	4	5
Temporo-sphenoidal abscess	3	1	3	7
Cerebellar abscess	1		3	4
Total	5	2	13	20

Patteson⁴ records four instances of papillitis in twenty-eight cases of brain-abscess, and twenty-one of papillitis in twenty-two cases of lateral sinus thrombosis.

In addition to the above, the following examples have been collected from the more recent literature :

Name of Observer.	Disease.	Form of Neuritis.
Ballance ⁵	Sinus phlebitis.	Double.
" 6	" "	None.
" 7	" "	Slight double.
" 8	" "	None.
" 9	" "	Slight double.
Ferrier ¹⁰	Cerebral abscess.	Double.
Parker ¹¹	Sinus phlebitis.	Double.
Barr ¹²	Cerebellar abscess involving lateral sinus.	Present.

¹ Goulstonian Lecture, British Medical Journal, March 22, 1890.

² Hunterian Lecture, 1889.

³ St. Thomas's Hospital Reports, vol. xvi.

⁴ Dublin Journal of Medical Science, July, 1890.

⁵ Lancet, 1890, vol. i. p. 804.

⁶ Ibid., 1890, vol. i. p. 1057.

⁷ Ibid.

⁹ Ibid.

¹⁰ British Medical Journal, 1888, vol. i. p. 530.

¹¹ Liverpool Medico-Chirurgical Journal, January, 1892.

¹² Zeitschrift für Ohrenheilkunde, vol. xx. p. 273.

⁸ Ibid.

Name of Observer.	Disease.	Form of Neuritis.
Greenfield ¹	Cerebral abscess.	Single.
Pritchard ²	" "	None.
" ³	Extra-dural abscess.	None.

The optic neuritis, it will be seen, is in the majority of cases bilateral. Keller ⁴ says that it usually begins on the affected side, but tends to become double. Cases which remain unilateral throughout are usually on the affected side. From the above tables we find that in thirty-three cases of thrombosis, twenty-nine, or eighty-eight per cent., have optic neuritis; and in forty-two cases of brain-abscess, thirteen, or thirty-one per cent., show the same condition. Undoubted instances of uncomplicated meningitis have been but rarely reported. The above tables include but five examples, in all of which the optic-nerve disturbance was present. If these percentages are trustworthy, the presence of optic neuritis would favor the diagnosis of meningitis or sinus phlebitis as more probable than that of abscess.

Pitt ⁵ says that papillitis suggests thrombosis more than any other lesion, whilst Lawford and Edmunds ⁶ seem to prove in their series of observations that all cases of optic neuritis are consecutive to meningitic inflammation.

Ballance ⁷ remarks that "neuritis is very rarely associated with extra-dural collections of pus." In a certain number of cases well-marked neuritis occurs in conjunction with suppurative disease of the ear, without other gross clinical evidences of intra-cranial disease.⁸ These are probably cases of meningitis not sufficiently severe to give recognizable diagnostic symptoms. Optic neuritis always adds much to the seriousness of the prognosis and suggests the propriety of radical measures. Zaufal ⁹ and W. A. Lane¹⁰ advise operation at once upon the first symptom of the beginning of such a form of neuritis.

In addition to the gross objective changes in the optic nerve head found by the ophthalmoscope, clinical study often yields important subjective data as to the position and degree of the disturbance caused by the offending mass. Thus, should a break in the visual field ordinarily known as homonymous hemianopsia¹¹ be present, it will be presumable that the opposite

¹ British Medical Journal, February 12, 1887.

² Archives of Otology, 1890.

³ Ibid.

⁴ Monatsschrift für Ohrenheilkunde, June, 1888.

⁵ Lancet, 1890, vol. i. p. 841.

⁶ Transactions of the Ophthalmological Society of the United Kingdom, Nos. 3, 4, 5, and 7.

⁷ Lancet, 1890, vol. i. p. 1116.

⁸ Styx, Zeitschrift für Ohrenheilkunde, vol. xix. p. 244; Barker, Transactions of the Clinical Society, London, vol. xxiii.; Sainsbury and Battle, Transactions of the Clinical Society, London, 1890; Fulton, Archives of Otology, vol. xiii.

⁹ Prager Medicinische Wochenschrift, April 15, 1891.

¹⁰ Lancet, September 26, 1891.

¹¹ Truckenbrod, Archives of Otology, vol. xv.

optic tract is involved. Again, should both the blind areas be situated temporally, it is probable that the brunt of the disturbance will have fallen upon the anterior portion of the optic chiasm.

Were we possessed of instruments of sufficient precision, it is probable that the other sensory manifestations of coincident ocular disease could be made evident. For example, it is supposable that the parts supplied by the sensory fibres of the fifth might under certain conditions give anæsthesias and paræsthesias which could be readily recognized by instruments for measuring the degree of sensibility. In like manner surface thermometry might be of use in the detection of symptomatic changes in local temperature. Similarly, motor derangements may manifest themselves; derangements may appear that require only careful study of the concomitant symptoms to give answer as to their position, their variety, and their intensity.

Several forms of paralysis of the cranial nerves or branches thereof have been noticed in connection with aural disease. Probably the most common of these is paralysis of the facial. It may be produced in two ways: first, by inflammation, without caries, of the osseous canal spreading from the mucous membrane of the middle ear to the bony wall of the Fallopian canal and to the sheath of the facial nerve; second, by caries and necrosis of the Fallopian canal itself. No marked difference is observed in the symptoms of the paralyses produced by these causes. The ear-symptoms in connection with facial palsy may be very varied. Purulent otitis media,¹ the presence of foreign bodies in the auditory canal,² non-perforative catarrh of the tympanic cavity,³ necrosis of the labyrinth,⁴ and malignant tumors of the middle ear, as fibro-sarcomata,⁵ are all cited as having been observed in connection with this lesion.

The grade and position of the paralysis will naturally depend either upon the amount and location of the pressure exerted on the nerve or upon the change within the nerve-tissue itself.

As before stated, lesions of other nerves connected with the visual apparatus are also occasionally noted as occurring coincidently with disease of the ear. Abducens paralysis has been seen in one or two cases in which there was intra-cranial involvement.⁶ The phenomena of muscle incoördination, such as convergent and divergent squint, diplopia, and various pupillary reactions, have also been observed in connection with otitic disturbances.

Three very interesting cases of purulent inflammation of some part of

¹ Politzer, *Lehrbuch der Ohrenheilkunde*.

² P. Verdos, *Revista de Laringologia, Otologia y Rinologia*, Enero, 1890.

³ Roosa, *Zeitschrift für Ohrenheilkunde*, Bd. ix.

⁴ Toepfitz, *Archives of Otolaryngology*, April, 1892, p. 174; Christinneck, *Archiv für Ohrenheilkunde*, vol. xviii. p. 293.

⁵ Gruber, *Diseases of the Ear*, English translation, p. 316.

⁶ Keller, *Monatsschrift für Ohrenheilkunde*, June, 1888.

the eyeball itself in conjunction with a purulent form of ear-affection are to be found in recent literature. In all three the inflammatory reaction took the form of a purulent irido-choroiditis, rapid in its course and totally destroying sight. Two explanations for the supposed cause of this phenomenon have been suggested. First, an affection arising from septic emboli carried from the ear through the circulation into the choroidal vessels. Second, direct extension of the purulent process by continuity of tissue to the membranes of the brain, and thence along the sheath of the optic nerve to the sub-choroidal lymph-space. Both observers¹ incline to the idea that the first is the more probable explanation.

A very interesting form of ocular lesion produced by primary auditory disease is nystagmus. Instances are noted in which simple pressure on the tragus,² the injection of warm or cold water,³ or the presence of a cerumen plug, polyp,⁴ or other foreign body, produced marked spasmodic oscillatory movements of the eyeball. Most or all of the cases had purulent otitis media.

In all these examples there was supposed to have been "transmission of pressure upon or irritation of the semicircular canals, and from these a propagation of changes through some part of the central nervous system," the cerebrum or the cerebellum, or possibly through both.⁵

Experiments upon animals have proved that direct irritation of the semicircular canals will produce a typical nystagmus.⁶ Analogous to this form of clonicism is another symptom caused by the very same conditions. Cerumen plugs,⁷ foreign bodies, syringing of the ear,⁸ etc., have all produced blepharospasm. One case is cited in which the spasmodic action corresponded to a cramp of the stapedius muscle.⁹ It is easy to comprehend that this spasm is identical with that provoked by foreign bodies located in the conjunctival sac, the neuralgia from simple irritation of the ophthalmic branches of the fifth, or the direct reflex from decaying teeth.

¹ Kipp, *American Journal of the Medical Sciences*, April, 1884; Pomeroy, *New England Medical Monthly*, January, 1889.

² H. Jackson, *Transactions of the Ophthalmological Society of the United Kingdom*, vol. iii. p. 261.

³ Cohn, *Berliner Klinische Wochenschrift*, No. 43, 1891.

⁴ Pflüger, *Deutsche Zeitschrift für Praktische Medizin*, 1878, No. 35.

⁵ Jackson, *Transactions of the Ophthalmological Society of the United Kingdom*, vol. iii.

⁶ Cyon, *Les Rapports Physiologiques entre le Nerf Acoustique et l'Appareil Moteur de l'Œil*, *Comptes-Rendus*, 1876, vol. i.

⁷ Buzzard, *Practitioner*, 1878.

⁸ Ziem, *Deutsche Medicinische Wochenschrift*, 1885, No. 49.

⁹ Gottstein, *Archiv für Ohrenheilkunde*, vol. xvi. p. 61.

II. AUDITORY LESIONS DEPENDENT UPON DISTURBANCES TAKING PLACE PRIMARILY IN THE VISUAL APPARATUS.

A small but interesting group of cases has been reported of associated eye- and ear-symptoms in which the primary lesion existed in the eye.

Five instances of glaucoma have been observed which existed contemporaneously with diminution of hearing of various grades.¹ In at least two cases marked improvement of audition is said to have followed the operation of iridectomy.

It has been asserted that the onset of certain cases of corneal disease was accompanied by deafness.² Four instances are recorded in which iridectomy was done with a distinct improvement in both the eye- and the ear-symptoms.

Inflammatory intra-cranial disease following panophthalmitis, after extraction of cataract, is accredited with having caused deafness in at least one instance.³ Unilateral loss of hearing is also known to have followed in one case of traumatic evulsion of the eyeball of the corresponding side.⁴

III. COINCIDENT OPHTHALMIC AND AURAL LESIONS ARISING FROM OTHER CAUSES.

Disorders of the Vascular System.—*Emboli* may affect both the organ of hearing and that of vision. Coincident emboli of the vessels supplying both organs would, however, be exceedingly rare, and it is doubtful if such a case has ever been reported. Two cases have, nevertheless, been reported of embolism of the right middle cerebral artery with softening of the right cerebral hemisphere. In the first of these⁵ the symptom noted was deafness. In the second case⁶ the ocular symptoms were double optic neuritis and slight changes in the retinae. In neither of the instances were associated symptoms noted. Much more common is embolus of a smaller or terminal vessel,—i.e., the internal auditory artery,⁷ the central artery of the retina,⁸ or the choroidal vessels.⁹ The lesions produced will in these cases be purely local.

Thrombosis of the cerebral sinuses, usually lateral or cavernous, has often been found associated with ophthalmic and aural symptoms. As it is almost always a result of purulent ear-disease, it has been discussed under that heading.

¹ Rampoldi, *Annali di Ottalmologia*, vol. xviii. p. 184.

² Davidson, *Annales d'Oculistique*, vol. vii. p. 125; Dransart, *ibid.*, 1880.

³ Moos, *Archives of Ophthalmology and Otology*, vol. vii. p. 492.

⁴ Dransart, quoted by Rampoldi, *Annali di Ottalmologia*, 1889, p. 194.

⁵ Kauffmann, *Berliner Klinische Wochenschrift*, 1886.

⁶ Mackenzie, *Brain*, January, 1879.

⁷ Moos, *Archives of Ophthalmology and Otology*, vol. vii.; quoting Friedrich.

⁸ Tay, *Transactions of the Ophthalmological Society of the United Kingdom*, 1881, p. 355.

⁹ Knapp, *Archiv für Ophthalmologie*, vol. xiv.

Deep-seated *aneurism*, especially that of the basilar arteries, may produce auditory derangements, though they are said to seldom, if ever, cause any visible dilatation of the retinal arteries. It is probable, however, that were ophthalmoscopic examination more frequently made in such cases, associated vascular changes in the retina and optic nerve-head might be found.

Sudden *hemorrhages* or apoplectic extravasations occasionally cause disturbance of hearing, but in proportion to their frequency they rarely do. A great variety of ocular symptoms has been noticed, from simple enlargement of the retinal veins to marked optic neuritis. Loss of sight may occur without decided ophthalmoscopic change, and in the graver forms permanent blindness may ensue.

In *leukæmia* both ear- and eye-symptoms present themselves. Of the former, deafness is the most prominent, and is dependent upon hemorrhagic and inflammatory changes in the middle and internal ears. These changes are thought to be favored by the existence of old middle-ear catarrh.¹ In the eye serious symptoms have been noticed. Retinitis, with or without hemorrhagic extravasation, is likely to occur. In addition to this may be found white and yellow thickenings in the fundus, especially in the periphery and about the macula lutea.

In *pseudo-leukæmia*, or Hodgkin's disease, deafness is not infrequently produced by the growths in the pharynx, whilst at times the optic nerve-head may appear of a dirty red-gray tint, with peculiarities in the retinal blood-columns.

Disorders of the Nervous System.—*Anæmia* of the brain, if unassociated with other disorders, usually produces but slight and transitory aural symptoms. Giddiness or subjective noises may be found in some instances, with or without impairment of hearing. In some cases loss of sight during the attack has been observed. If this persists, permanent amaurosis may result.²

In the auditory apparatus cerebral *hyperæmia* causes tinnitus and vertigo. These are always aggravated by any condition which tends to produce an increase of blood in the cranial cavity. The retinal circulation is probably increased during the active stage.

Meningitis frequently brings on unilateral or bilateral deafness, due no doubt to inflammatory changes in the corresponding nerves within the cranium or to an extension of this inflammatory process to the labyrinth. The deafness is usually not persistent, total recovery soon taking place. Only in exceptional cases is the deafness associated with unilateral or bilateral blindness, oculo-motor palsy, or paralysis of other nerves. The causative factor of the disturbance of the second nerve in these cases is probably a descending inflammatory action affecting the neuroglia. Brailey

¹ Gradenigo, Archiv für Ohrenheilkunde, Bd. xxii.

² Gowers, Medical Ophthalmoscopy, 1882, p. 123.

and Edmunds¹ found numerous evidences of the actual descent of the inflammatory material along the arterioles to the optic nerve tissue. It cannot be denied that in some cases of meningitis optic neuritis is produced by a simple increase of intra-cranial pressure.

Intra-cranial growths produce in a comparatively small percentage of cases coincident disturbances of vision and audition. Ladame² has collected three hundred and thirty-one cases of cerebral tumor, in which one hundred and seventy-one presented disturbances of vision,—sixty being cases of amaurosis,—thirty-one showed disturbances of hearing, and twenty-five were found to have both senses involved. These coincident cases occurred principally when there was tumor at the base of the brain. In forty-five cases of cerebral tumor, Lebert³ found eight instances in which sight and hearing were affected at the same time.

The most prominent of the aural symptoms, which of course vary greatly with the size, position, and nature of the growth, are subjective noises, vertigo, and dulness of hearing of varying degrees up to total deafness. When this last is reached the subjective noises are, as a rule, lost. In the majority of cases due to cerebral tumor the deafness is unilateral, but may become bilateral owing to increased growth of the neoplasm or to pressure produced upon the unaffected half of the brain. In tumors of the cerebellum, even when unilateral, there is often bilateral deafness, in spite of the fact that there is no direct pressure exercised by the growth upon the opposite auditory nerve. Commonly, in cases involving both the eye and the ear, the deafness is a beginning symptom, the ocular disturbances not occurring till later in the course of the disease.

The most important eye-symptom of tumors of the brain is papillitis, or optic neuritis. Associated with this there may be in some stage of the disease disturbances of the other nerves of the eye, and different forms of anæsthesia and paralysis. Gowers⁴ maintains that "optic neuritis is the ocular lesion in intra-cranial growths, which are on the other hand its most frequent causes." He further says that it occurs in his experience in eighty per cent. of all cases of intra-cranial growths.⁵ Position has apparently no direct influence upon the occurrence of optic neuritis, neither has the size nor the nature of the growth. The supposed mechanisms of its production are, first, the rapidity of growth; second, the direct effect of the tumor's mass upon the intra-cranial pressure; and, third, the mechanism of meningitis.

Abscess of the brain is very similar to tumor in that organ in regard to the character of the symptoms produced. Its differential diagnosis from

¹ Transactions of the Ophthalmological Society of the United Kingdom, 1881, p. 112, *et seq.*

² Die Symptomatologie der Gehirngeschwülste, Würzburg, 1865.

³ Virchow's Archiv, Bd. iii. p. 463, and *ibid.*, Bd. ix. p. 331.

⁴ Medical Ophthalmoscopy, 1890, p. 156.

⁵ *Ibid.*

the latter condition is most difficult. History of previous ear-disease, trauma, or purulent disease of some large trunkal viscus, especially the lung, will always have its influence upon the establishment of the diagnosis. Variations of temperature both local and general would also have their weight in the consideration, although in encapsulated abscess, as in tumor, normal or even subnormal temperature is usually present.¹

While *tuberculosis* is known to invade the choroid, the retina, and even the optic nerve itself, producing the gravest symptoms, it very rarely leads to any recognizable auditory derangement.

Epidemic cerebro-spinal meningitis often affects the organs of both sight and hearing. The aural symptoms, which generally begin on the third or fourth day of the illness, include subjective noises and deafness, which latter is apt to be not only bilateral and complete, but permanent as well. A very frequent late symptom is loss of equilibration. In some instances the deafness is associated with unilateral disturbance of vision.

Optic neuritis is the most prominent ophthalmic symptom, but, fortunately, is found only in the gravest forms of the disease. The course is usually a progressive one, and, as a rule, nerve-atrophy supervenes rapidly. In many such cases a grave form of suppurative choroiditis, both monocular and binocular in type, especially the latter, takes place, causing shrinkage of the globe and permanent blindness. Such a condition is ordinarily known as pseudo-glioma.

Internal hydrocephalus, while a frequent cause of deafness, is but rarely responsible for changes in the eye. A few instances of partial nerve-degeneration have occurred, and at times engorgement of the retinal veins has been noticed.² Optic neuritis has occasionally been found.

As far as known, the auditory derangements in *epilepsy* consist wholly in the auræ, which take the form of noises in the ear, odd sounds, musical tones, or occasionally voices. The eye-symptoms, which are more easily obtained, consist in disturbance of vessel-calibre during the paroxysmal state, with ophthalmoscopic evidences of chronic perivascularitis, optic-nerve degeneration, and increase of connective-tissue elements in chronic cases that have had a great number of frequently-repeated seizures.

In *migraine*, or hemicrania, the ophthalmic symptoms are most common. They consist of temporary anæsthesias, especially symmetrical and hemianopic in character, followed or preceded by all manner of subjective paræsthesias, which assume definite coloration or form. In the ear subjective noises are sometimes present.

Posterior sclerosis of the spinal cord undoubtedly causes derangements of audition, although conflicting testimony is brought forth. Erb³ found in some cases an atrophy of the auditory nerve in association with degenera-

¹ Bramwell, *Intra-Cranial Tumors*, p. 142.

² Oliver, *Cyclopædia of the Diseases of Children*, vol. iv. p. 192.

³ Ziemssen's *Handbuch*, S. 142.

tion of the cord. Lucae,¹ on the contrary, cites two cases in which deafness was due to middle-ear catarrh, and the auditory nerve was free from change. The ocular symptoms, on the other hand, which embrace gray degeneration of the optic nerve, conjunctival and palpebral anæsthesia, pareses, and even entire want of action of certain physiological muscle-groupings, are of frequent occurrence. Gray degeneration of the optic nerve, when occurring early in the history of the case, frequently leads to total blindness long before the ataxic symptoms become sufficiently pronounced to affect seriously the larger muscles. If the motor groupings be early involved, the sensory changes seem to remain much longer undisturbed.

Unclassified Neuroses.—Two favorite regions for the location of the manifestations of *hysteria* are the eye and the ear. While in not a large percentage of the cases are both organs involved, instances of this are reported. Charcot² cites an example in which with bluntness of hearing was associated double contraction of the visual field, more marked on the right side, upon which side violet was not distinguished, the fields for red being larger than those for blue.³

Very common symptoms referred to the ear are noises, tinnitus, or dulness of hearing without the slightest objective change. The attacks are usually periodical.

GENERAL DYSCRASIE.

In *nephritis*, whether acute or chronic, the ear is almost never involved. On the other hand, probably on account of easier recognition, the eye appears to suffer from the general vascular disturbance. Both the choroid and the retina undergo changes due to fatty degeneration of their vessels. One case has been reported in which Ménière's disease was associated with a double optic neuritis, in which, however, the undoubted cause of both conditions was an intercurrent Bright's.⁴

In *diabetes* affections of the sight are not rare. Dimness of vision—with or without retinitis, hemorrhages, and yellow splotches—occurs early and may terminate in partial or complete blindness. Troubles of accommodation are also frequent. The diabetic condition favors the formation of cataract.

In diabetes, pruritus and furuncles of the external auditory canal are sometimes observed, whilst purulent otitis media is occasionally developed. Subjective auditory sensations and impairment of hearing may also be present.

¹ Verhandlungen der Berliner Medicinischen Gesellschaft, Bd. i.

² Clinical Lectures on Certain Diseases of the Nervous System, 1888, p. 131.

³ This perversion of the normal order of color-fields is probably due to mere sensory fatigue, and had proper care been taken to rest the eyes between each color tried, the ordinary routine of area might have been obtained. *Vide* Oliver, Cyclopædia of the Diseases of Children, vol. iv. p. 215.

⁴ Pooley, New York Medical Journal, January 8, 1887.

Coincident lesions of the cornea, the iris, the retina, the external auditory meatus, the membrana tympani, and now and then of the Eustachian tube are found frequently in individuals suffering from *secondary syphilis*. Hutchinson¹ was the first to call attention to the fact that in *hereditary syphilis* both eye- and ear-affections were found. His experience was that deafness without other objective symptom than a dryness and opacity of the membrana tympani was very often associated with disease of the eye, as interstitial keratitis, iritis, and irido-choroiditis, and appeared at about the same time as the ocular lesion. Hinton, on the contrary, says that in every case of hereditary aural syphilis with deafness the patients had previously suffered from impaired vision. Deafness in this condition is usually, however, of slow development. The query arises whether it is not possible that, whilst the ocular lesion would be early or even immediately observed, the failure of hearing in its beginning stages would pass unnoticed.

Hutchinson,² from the fact that the deafness is in many cases bilateral, and there is no adequate change in the tympanic membrane, believes that the cause is to be found in disease either of the auditory nerve or of its distribution in the labyrinth.

In *typhoid fever* the special senses are often impaired, especially the sense of hearing, and deafness in one or both ears is frequently marked. Purulent otitis media is an occasional complication. Optic neuritis is occasionally found associated, probably due to a non-recognized meningitis. It is said, however, that actual meningitis is exceedingly rare,³ so much so that, in the diagnosis between beginning intra-cranial involvement from purulent ear-disease and typhoid fever, the early presence of optic neuritis would justify the exclusion of the latter.⁴ Embolism of the retinal arteries has also been noted.

Otitis media has been repeatedly observed in *relapsing fever*, although not so frequently as iritis or irido-choroiditis. These conditions are supposed to occur rather from metastases than from the bacillus itself.

While secondary affections of the ear following *scarlet fever* are nearly always local and the result of direct extension of the inflammatory process, those of the eye are due either to the nephritis often associated with this disease or to a complicating meningitis. In the first group we have suppurative otitis media with perforation of the membrana tympani and even subsequent caries of the bone. Permanent deafness and facial paralysis may also result from the same cause. Among the eye-symptoms, neuro-retinitis with rapid failure of vision has often been noted. Should sudden blindness appear, it is probable, judging from the free action of the

¹ A Clinical Memoir on Certain Diseases of the Eye and Ear consequent on Inherited Syphilis, etc., 1863.

² Ibid.

³ Wilson, Cyclopædia of the Diseases of Children, vol. i. p. 471.

⁴ Ballance, Lancet, 1890, vol. i. p. 1116.

irides, that the brunt of the disease has fallen upon the visual apparatus posterior to the corpora quadrigemina. Grave changes in the choroid with liquid effusion between the choroid and the retina may occur. In these cases the prognosis is necessarily grave.

During the paroxysm of *pertussis* we may observe not only sub-conjunctival ecchymoses, but hemorrhagic extravasations into the retina as well, the latter producing marked defects in the vision. In the same manner hemorrhage from the ear is known to have occurred. Acute suppurative of the middle ear may follow as a sequel of whooping-cough.¹

In *diphtheria* the Eustachian tube is sometimes, but rarely, involved. The process is often followed by a type of otitis media that rapidly takes the chronic form. Grave optic-nerve disease has been observed as a sequel to diphtheria. One case has been reported of double chorio-retinitis with partial degeneration of the optic nerve.²

Rubeola, like the rest of the exanthemata, is liable to be complicated by either nephritis or meningitis. Most of the ophthalmic lesions noticed in this disease have been due to one of these causes. The only ear-lesion noted is suppurative otitis media.

In *variola*, pustules may form in the Eustachian tube, and a median otitis follow, which may result in deafness. Deep lesions of the eye are very infrequent, whereas ulcers and even abscesses of the cornea are often seen; before the introduction of vaccination these were very common causes of blindness.

Gout at times manifests itself by deposits in the form of nodules of urates on the helix of the ear, on the eyelids, and sometimes even between the layers of the cornea.³

In *influenza* the common complication is otitis media, with, in a large proportion of cases, mastoid involvement. One case is reported in which the mastoid trouble was associated with an orbital cellulitis, causing moderate exophthalmos.⁴ Conjunctivitis, as a mere expression of the general disturbances of the mucous membranes, is frequently associated with the aural symptoms.

¹ Roosa, Treatise on the Diseases of the Ear, 1885, p. 332.

² Oliver, Transactions of the American Ophthalmological Society, 1887.

³ Chevallereau, Recueil d'Ophthalmologie, Avril, 1891.

⁴ Zimmermann, Archives of Otology, January, 1892.

PART II.

Diseases of the Nose and Naso-Pharynx.

ANATOMY AND PHYSIOLOGY OF THE NOSE AND NASO-PHARYNX.

BY ALEXANDER W. MACCOY, M.D.,

Professor of Laryngology in the Philadelphia Polyclinic and College for Graduates in Medicine, Philadelphia, Pa.

ANATOMY OF THE EXTERNAL NOSE.

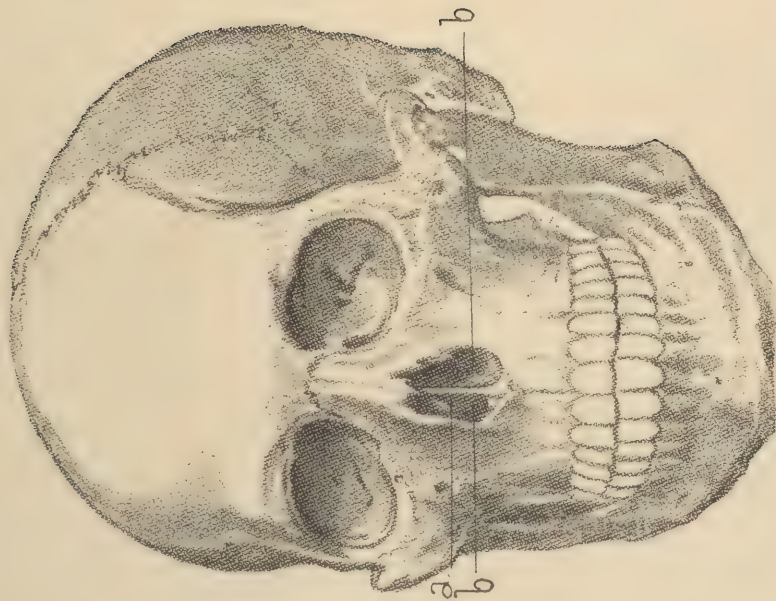
“THE external nose is composed of a bony and cartilaginous framework covered with muscular tissue and integument.”

1. *The bony framework* is composed of (a) the nasal bones; (b) the nasal processes of the superior maxillaries.

(a) The nasal bones are situated in the upper portion of the external nose, and are joined to each other on the median line by a thick serrated edge, and on each side to the nasal processes of the superior maxillaries by a thin edge bevelled at the expense of its internal face. Each nasal bone is longer than wide, thicker above than below, smooth, slightly convex from side to side on its outer surface, and concave upon its inner surface. The upper margin articulates with the frontal bone and nasal spine; the lower margin is continuous with the upper lateral cartilage of the nose.

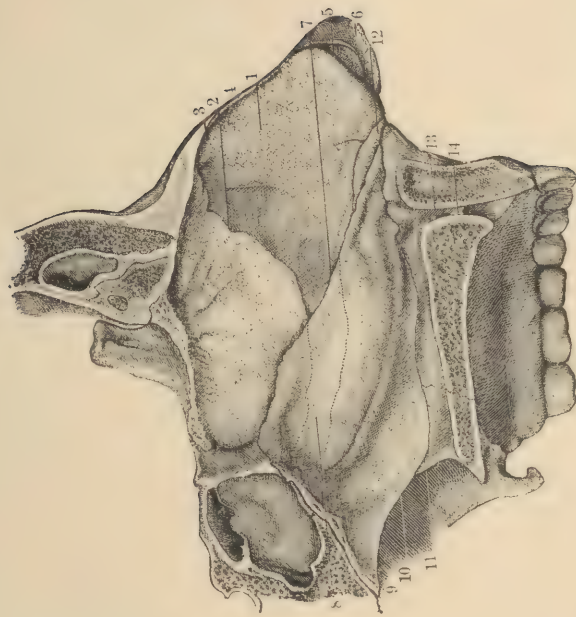
(b) The nasal processes of the upper maxillaries are broader below than above, and incline upward and slightly backward to articulate with the frontal bone. The bony framework of the nose forms an extremely resistant arch, narrow and very thick above, where it articulates with the frontal bone; wider and very thin below, where it terminates in a sharp edge. Its upper part, designed as it is for protection, is admirably adapted for this purpose, being distinguished by its solidity; while the lower part, united by thin and flexible cartilages, is itself, like them, thin and light. Behind and for its entire length this arch is supported by the perpendicular plate of the ethmoid. (See Fig. 1.)

FIG. 1.



a, perpendicular plate of the ethmoid; *b*, *b*, anterior orifices of the nasal fossae. (Sappey.)

FIG. 2.



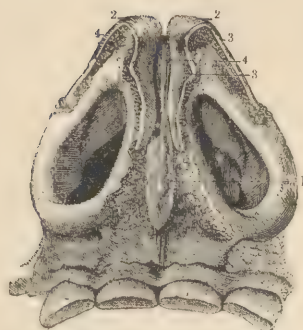
1, cartilage of the septum; 2, upper and posterior edge of this cartilage; 3, upper and anterior edge of this cartilage; 4, profile of the right lateral cartilage; 5, lower and anterior edge of the cartilage of the septum; 6, internal part of the wing of the nose on the left side; 7, lower and posterior edge of the cartilage of the septum; 8, intra-vomerian prolongation of this cartilage, its upper and lower edges being indicated by dotted lines; 9, upper edge or base of the vomer; 10, posterior edge of the vomer; 11, its lower edge united to the palatine bones and to the palatine process of the superior maxillary; 12, summit of the vomer; above this summit is seen a little accessory cartilage (constant), which advances as far as the antero-inferior nasal spine. 13, anterior palatine canal, right side; 14, anterior palatine canal, left side. (Sappey.)

FIG. 3.



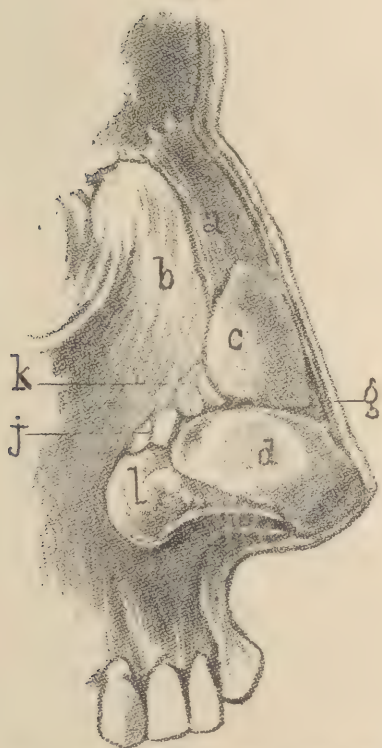
CAVITY OF THE NOSTRILS SEEN FROM BELOW.—1, nostril of the right side; 2, its external wall; 3, 3, lower edge of this wall; 4, 4, projection formed by the lower edge of the lateral cartilage of the nose; it makes part of the upper orifice of the nostril, which it narrows, as it is attached antero-posteriorly to the septum of the nasal fossæ; 5, projection of the cartilage of the wing of the nose. (Sappey.)

FIG. 4.



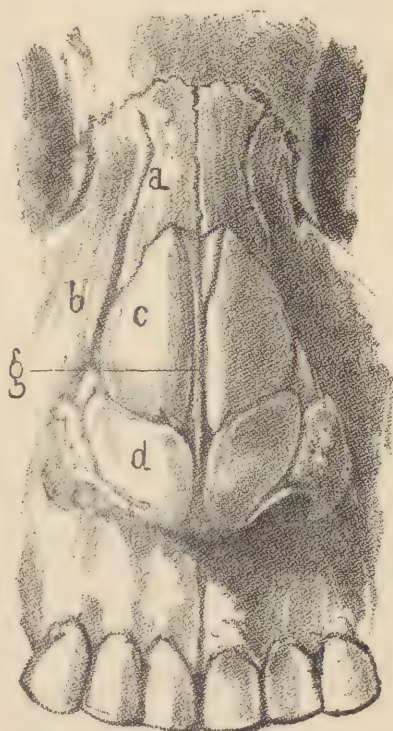
CAVITY OF THE NOSTRILS AND THE CARTILAGES WHICH CONTRIBUTE.—1, 1, antero-inferior edge of the cartilage of the septum; 2, 2, middle part of the cartilage of the wings of the nose; 3, 3, internal face of these cartilages; 4, 4, their external face, of which one sees here only the lower edge. (Sappey.)

FIG. 5.



a, bones proper of the nose; b, ascending processes of the maxillary bones; c, upper lateral cartilages of the nose; d, cartilages of the nostrils (lower lateral) folded back on themselves; each has two faces; e, cartilage of the septum; f, supplementary cartilaginous plates; g, fibrous plate filling the space existing between the lateral cartilages and the cartilages of the nostrils; h, fold of skin forming the wing of the nose. (Hirschfeld.)

FIG. 6.



2. *The Cartilaginous Framework.*—The nasal cartilages composing the cartilaginous framework of the nose are the septal, lateral, and sesamoid cartilages.

(a) The septal cartilage takes its part in the cartilaginous framework of the nose as a supporting partition, and also completes the nasal septum anteriorly. Its upper and posterior edge is united to the perpendicular plate of the ethmoid in the same manner as are the ribs with the costal cartilages. Its upper and anterior edge extends from the nasal bones proper to the lobe of the organ. Above it is continuous with the lateral cartilages, below it is free. The lower and anterior edge, the shortest of all, is directed obliquely downward and backward. The lower and posterior edge is attached in front to the crest of the union of the palatine processes of the superior maxillary bones, and behind to the most sloping part of the anterior edge of the vomer. The faces of the septal cartilage are, in general, smooth. (See Fig. 2.)

(b) The lateral cartilages are composed of two upper lateral and two lower lateral. The upper lateral are triangular in shape and continuous with the septal cartilage. Sappey considers them as part of the septal cartilage. The two lateral plates of the septal cartilage are attached to the broad and grooved portion of the septal cartilage. These, with the lateral cartilages proper (lower lateral), serve to support the outer wall of the nostrils. These lateral plates are attached above to the sharp edge of the nasal bones; their lower margins are free and somewhat curved inward, making a slight projection inside the nostril. The lateral cartilages proper (lower lateral) are entirely distinct from the septal cartilage; they enter into the construction of the tip of the nose, and support the outer and a small part of the inner walls of the nostrils. (See Figs. 3 and 4.) They are united at an acute angle, and, owing to the acute angle at which these cartilages are bent upon themselves, there is left a depression which is readily felt through the integument at the tip of the nose. These lateral cartilages overlap the lateral plates of the septal cartilages and help to form the framework of the wing of the nose. (See Figs. 5 and 6.) A smaller portion of these cartilages gives support to the septum between the nostrils, filling up the space left by the retreating border of the septal cartilage. These lateral cartilages are subject to great variation in contour, and have much to do with the individuality of each nose. The cartilages are bound together and the interspaces filled up with aponeurotic tissue, and they are slightly movable upon each other by muscular action. In addition to the median and lateral cartilages of the cartilaginous framework of the external nose are the accessory (sesamoid) cartilages. Those constantly found are four in number; often additional ones are present. These four constant accessory cartilages may be divided into anterior and posterior. The anterior are quite loosely attached to the septal cartilage by cellular tissue, and might be considered as appendages of it, while the posterior pair adhere closely to the cartilage. Besides the constant accessory cartilages, a variable number of

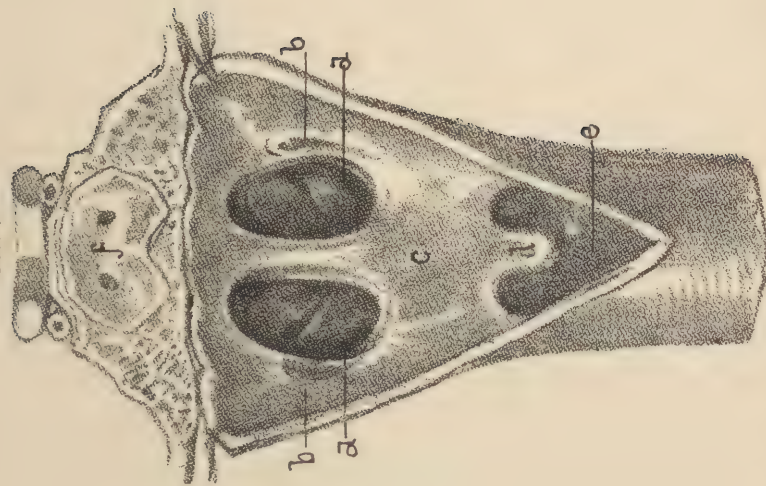
inconstant accessory cartilages may be present. These inconstant cartilages are situated sometimes in the space between the lateral cartilages and the cartilages of the wings of the nose. The outer and lower portions of the wings of the nose are composed chiefly of adipose tissue. The skin is firmly adherent over the cartilaginous portion of the nose, and included in it are a large number of sebaceous cysts, distributed especially freely in the alar portion.

3. *External Muscles of the Nose.*—For convenience, the muscles of the external nose may be divided into two groups under the general names of dilators and contractors. In the first group—dilators—may be included the elevators of the wing of the nose and upper lip, which have their origin in the nasal process of the superior maxillary bone, pass obliquely downward and outward, and are inserted into the cartilages of the wings of the nose; the dilator naris posterior, arising from the nasal notch of the superior maxillary and from the accessory cartilages, is inserted into the skin near the margin of the nostril; the dilator naris anterior, whose origin is entirely cartilaginous, lies immediately in front of the preceding and the compressor naris, which arises near the incisive fossa, and is inserted by means of a broad aponeurosis into the fibro-cartilages of the tip of the nose. Under the group *contractors* there are only the depressors, or muscles proper of the wings of the nose, which have their origin in the incisive fossæ lying between the mucous membrane and the muscles of the lip, and are inserted into the septum and the posterior portion of the wing of the nose. These muscles play a much smaller part in respiration and olfaction in man than in animals.

THE NASAL FOSSÆ.

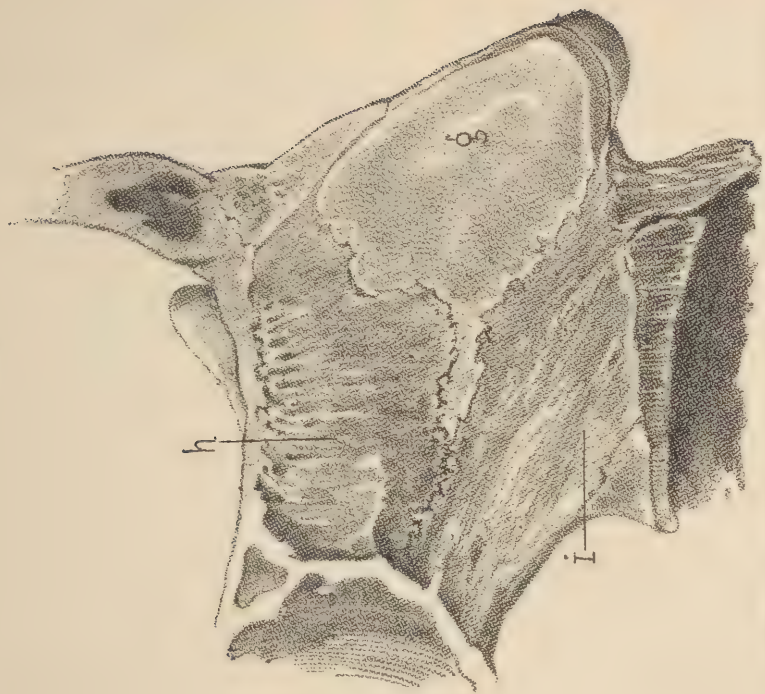
The nasal passages are two wedge-shaped cavities extending from the nostrils in front to the posterior nares behind. The posterior nares are two oval-shaped openings by which the nostrils communicate with the upper pharynx. (See Fig. 7.) The nasal fossæ are divided into two regions known as the vestibules and the nasal fossæ proper. The vestibules consist of that portion of the nasal fossæ limited by the cartilaginous framework of the nose, and they merge into the nasal fossæ proper, which extend from the ending of the vestibules to the naso-pharynx. The roof of the nasal cavities is somewhat arched from before backward, and narrow, and is composed of the nasal bones in front, the cribriform plate of the ethmoid in the middle, and the body of the sphenoid behind. The floor is formed by the palate bones and the palatine processes of the superior maxillaries. The plane of the floor of the nasal cavities is nearly horizontal, sloping slightly downward along its posterior portion. The plane of the floor of the nasal chambers proper is often of a different level from that of the vestibular portion. The nasal passages are separated from each other in the median line by the septum, which is composed of the perpendicular plate of the ethmoid above and the vomer below. (See Fig. 8.) The ar-

FIG. 7.



a, a, posterior openings of the nasal fossae, in which may be seen the three turbinated bones and the three meatuses; *b, b*, openings of the Eustachian tubes; *c*, soft palate; *d*, uvula; *e*, pharyngeal cavity; *f*, sphenoidal sinuses, in which may be seen the openings by which communication is had with the superior meatuses of the nasal fossae. (Hirschfeld.)

FIG. 8.



g, cartilage of the septum; *h*, perpendicular plate of the ethmoid; *i*, the vomer. (Hirschfeld.)

tiolation of the perpendicular plate of the ethmoid with the vomer leaves anteriorly a triangular space which is filled by a cartilaginous plate commonly known as the septal or triangular cartilage of the septum; maintained by Sappey, however, to be quadrilateral in shape. (See Fig. 9.) The septum is vertical and lies in the median line until early childhood, when there is usually a slight deviation to one or other side. The outer wall of each nasal passage is formed by the superior maxillary, lachrymal, palate, and sphenoid bones. This outer wall is traversed antero-posteriorly by three scroll-shaped bones, named, respectively, the inferior, middle, and superior turbinated bones. (See Fig. 10.)

Inferior Turbinated Bone.—The inferior turbinated bone, the longest of the three, is an elongated scroll of bone attached by its outer border to the outer wall of the nasal chamber. It is attached to the lower crest of the palatal bone posteriorly, and, by a hook-like process, to the inner wall of the maxillary sinus. Its inner border, at its anterior edge, is united to the inferior crest of the nasal process of the superior maxillary. This anterior narrowed extremity is rudimentary in man, and corresponds to what is known as the “alinasal” of quadrupeds. The posterior rounded extremity extends to the internal pterygoid process. The inferior turbinated bone is the most developed, the most compact in structure, and the only one of the three which is an independent bone. Its length varies from twenty-five to fifty millimetres, and its width from five to fifteen millimetres.

Middle Turbinated Bone.—The middle turbinated bone, the next in length, is more rolled round at its centre than at its extremities; it springs from the lateral mass of the ethmoid, and consists of a broad thin plate of bone which passes downward and is then curved upon itself in the same manner as the lower turbinated bone. Near its anterior free end a small projection—the agger nasi—is directed inward, and on the corresponding level of the septum there is a slight bulge. These two slight elevations make a defining line between the olfactory region above and the respiratory region below. (See Fig 2.)

Beneath the middle turbinated bone lies the long unciform process of the ethmoid. This may be described as a long, bony plate running downward and backward from the tip of the middle turbinated bone and almost parallel with its lower border. Its purpose is twofold,—to articulate with the superior maxillary bone by means of thin bony plates projecting from it to the antrum, and with the inferior turbinated bone by delicate processes from its lower border. These last-named processes close to a greater or less extent the opening between the nasal cavity and the antrum of Highmore. Beneath the middle turbinated bone and extending from near the anterior extremity downward and backward, is seen a deep furrow, the hiatus semilunaris. This is crescentic in shape, and has a direction downward and backward, the convexity looking forward. This furrow is bounded above by a prominence which is an expanded ethmoidal cell and is known as the “bulla ethmoidalis;” below, by the unciform process already described.

The superior extremity of the hiatus semilunaris presents a somewhat circular opening,—the orifice of the frontal sinus; following this furrow backward, we find it merging into an opening of more or less circular shape and of varying dimensions—the ostium maxillare—leading into the maxillary sinus. Behind this opening we occasionally find a second one leading into the same cavity, known as the ostium maxillare accessorium. In this same furrow, near the orifices of the frontal sinuses, we find the openings of the anterior ethmoidal cells.

Superior Turbinated Bone.—The superior turbinated bone, the smallest and least scroll-shaped of the three, also springs from the lateral mass of the ethmoid; in its posterior portion it is entirely distinct from the middle turbinated bone; anteriorly it is united with it. Posteriorly there is, in some cases, a horizontal slit in the superior turbinated bone which forms a fourth turbinated bone. This was first described by Santorini. Zuckerkandl states that it is present in about one case in three, and Voltolini asserts that it is always present in the negro race.

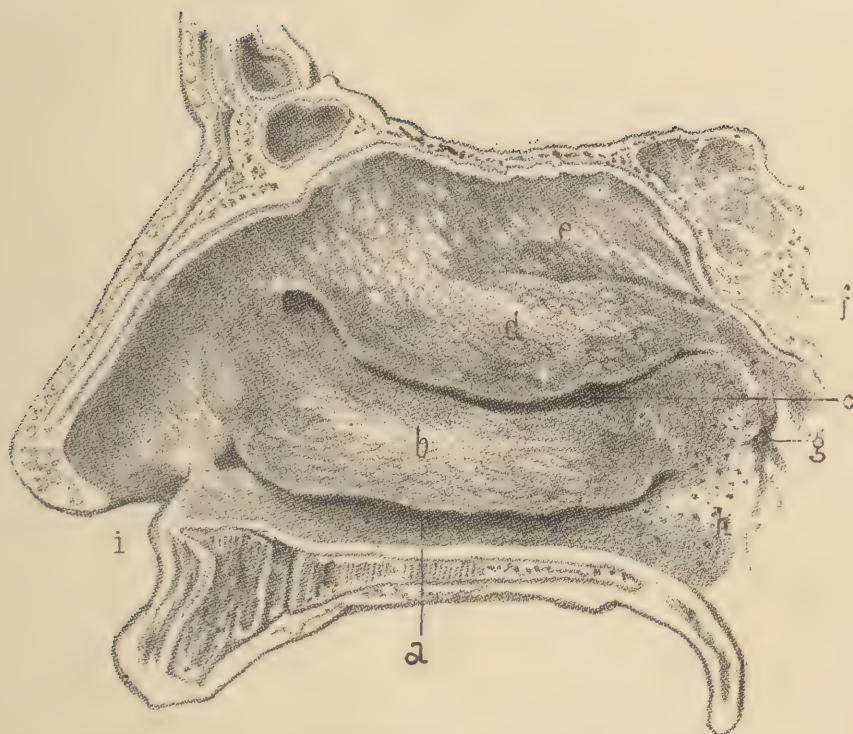
These turbinated bones are nearly parallel with one another, and divide each cavity into three passages,—the lower meatus, between the floor of the nose and the lower turbinated bone; the middle meatus, between the lower and middle turbinated bones; and the superior meatus, between the middle and superior turbinated bones. (See Fig. 11.) When a fourth turbinated bone occurs there is a fourth meatus.

Each nasal fossa has communicating with it four accessory cavities,—namely, the maxillary, frontal, sphenoidal, and ethmoidal sinuses. The maxillary sinus, or antrum of Highmore, is the largest of these cavities, and is hollowed out of the body of the superior maxillary; it is bounded above by the floor of the orbit, on its inner side by the outer wall of the nasal cavity, in front by the malar process of the superior maxillary, and posteriorly by the zygomatic face of the superior maxillary bone. The size of this cavity varies greatly in different individuals and even in races. This cavity opens into the middle meatus by the ostium maxillare. The frontal sinuses are two prism-shaped cavities which lie between the two tables of the frontal bone, the floor being formed by the roof of the orbit. These frontal sinuses are absent in early life and become fully developed in the adult. They communicate with the nares by the infundibulum,—a rounded opening in the anterior extremity of the hiatus semilunaris. Sometimes these cavities communicate with each other; in very few instances they communicate with the cavity of the orbit and with the cavities of the ethmoidal sinuses.

The sphenoidal sinuses are two rounded cavities hollowed out of the body of the sphenoid bone, and are separated from each other by a bony partition or septum. They communicate with the nares by a small opening in the superior meatus. Very rarely these sphenoidal sinuses are divided by a horizontal plate, making upper and lower cavities.

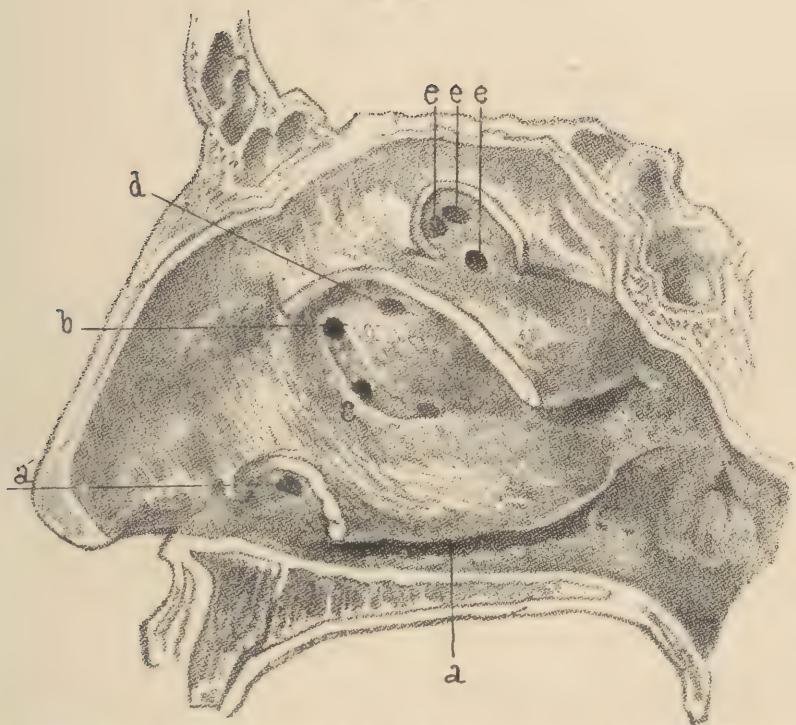
The ethmoidal sinuses, instead of being large hollow cavities, are com-

FIG. 11.



a, the inferior meatus; *b*, the inferior turbinated bone; *c*, the middle meatus; *d*, the middle turbinated bone; *e*, the superior meatus; *f*, the superior meatus; *g*, the mucous membrane of the Eustachian tube, with *h*, that of the soft palate and pharynx; *i*, continuation of the lining membrane with the skin. (Hirschfeld.)

FIG. 12.



a, inferior meatus; *a'*, inferior opening of the nasal (lacrimal) canal; *b*, inferior opening of the infundibulum, across which the lining membrane is extended into the anterior cells of the ethmoid and into the frontal sinus; *c*, opening of the maxillary sinus; *d*, supplementary opening of the anterior ethmoidal cells: these three openings are visible in the middle meatus; *e, e, e*, three small openings which establish the communication of the superior meatus with the posterior ethmoidal cells. (Hirschfeld.)

posed of a large number of cells, separated from each other by thin plates of bone. They are divided into two portions,—the anterior and posterior ethmoidal cells. The anterior ethmoidal cells open into the middle meatus by means of small openings called the ostia ethmoidalia. The posterior ethmoidal cells open into the superior meatus. These ethmoidal cells sometimes, but rarely, extend either into the sphenoidal cells, posteriorly, or into the frontal cells. They occasionally communicate with the orbital cavity. The lachrymal canal opens inferiorly into the lower meatus, well forward and underneath the lower turbinated bone. (See Fig. 12.)

Anatomy of the Mucous Membrane of the Nasal Fossæ.—The vestibular portion of the nasal chambers, in its lower part, is lined with cutaneous tissue reflected from the skin of the face. In the deeper portion of the vestibule the cutaneous tissue gradually shades into tissue composed of elements of both skin and mucous membrane. This cutaneo-mucous tissue soon loses its mixed character, and at the junction of the vestibule and the nasal chambers proper all the elements of true mucous membrane are present. Squamous epithelium covers the lining membrane of the vestibule, and numerous vascular papillæ and sebaceous follicles are present. In the lower portion of the vestibule are numerous stiff hairs, called vibrissæ. These hairs act as filters to the inspired air, and protect the respiratory tract from grosser foreign material. The mucous membrane of the nasal chambers proper is continuous with that of the upper pharynx, lines the walls of the accessory cavities, and extends into the Eustachian tubes. The epithelial layer is of the columnar variety, ciliated in the lower portion, but devoid of cilia in the upper portion. The portion of the nasal chambers covered with ciliated epithelium, embracing the lower turbinated and the lower half of the middle turbinated region, is known as the respiratory tract; the non-ciliated region, embracing the upper half of the middle turbinated, upper third of the septum, and superior turbinated region, is known as the olfactory tract. The fact that the functions of these two tracts of the nasal fossæ are entirely distinct accounts for the presence of ciliated epithelium in the one tract and its absence in the other. The mucous membrane lining the cartilaginous and bony septum is thin, firmly adherent in the bony portion, more loosely attached in the cartilaginous, and takes the form of perichondrium and periosteum. The configuration of the nasal chambers proper is greatly modified when covered with mucous membrane. (See Figs. 13 and 14.) The free space between the septum and the turbinated bones is lessened, the meatuses are narrowed, and the rugged and severe outlines are rounded and softened. The orifices leading into the accessory cavities are narrowed; especially may this be noticed in the orifice leading into the antrum of Highmore and at the outlet of the lachrymal duct. The mucous membrane in the antrum of Highmore lies in folds or reduplications, and the same peculiarity is noticeable in the upper portion of the infundibulum.

The Glands.—The glands found in the mucous membrane of the respiratory tract of the nasal chambers are of the tubular variety, generally single, sometimes agminate. They are numerous, and remarkable for their length, extending to the deeper layer of the membrane and often to the periosteum, so called. In the olfactory tract there are also tubular glands differing in function from those mentioned in the respiratory tract, and known as Bowman's glands. The walls of Bowman's glands are lined with rounded epithelium which at the lower extremity of these glands is large and granular and contains a considerable amount of pigment. In addition to the foregoing general characteristics of the mucous membrane lining the nasal chambers, there is to be noticed a special anatomy of the mucous membrane covering the turbinated bones. Upon no special anatomy have there been greater diversity of opinion as to its true structure and wider range of speculation as to its proper function. The two leading views on the subject are presented below.

Beneath the superficial layer of mucous membrane covering the faces

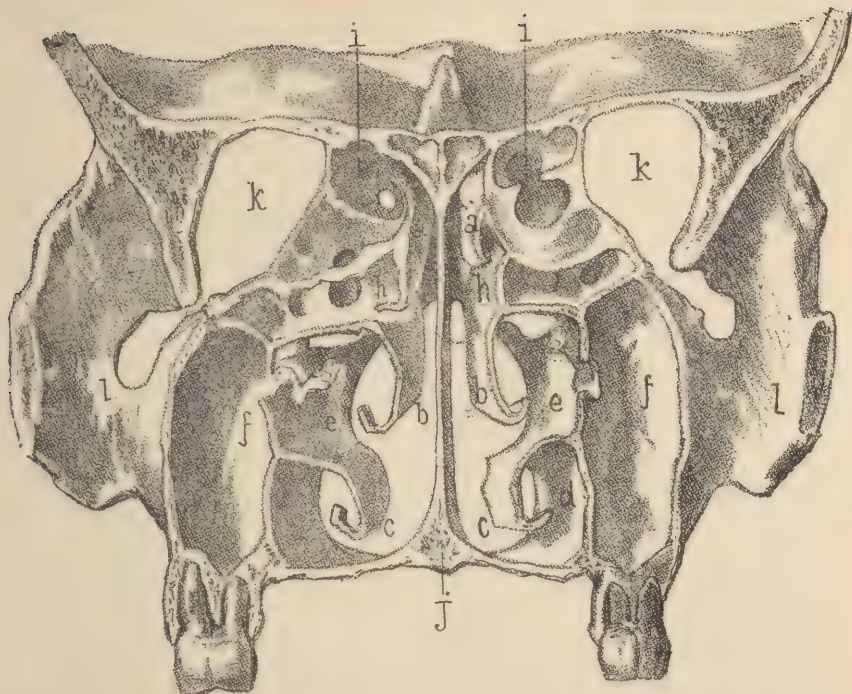
FIG. 15.



Section of the cavernous or erectile tissue of the middle and lower turbinated bones, inflated and dried, $\times 2$ diameters. (Bigelow.)

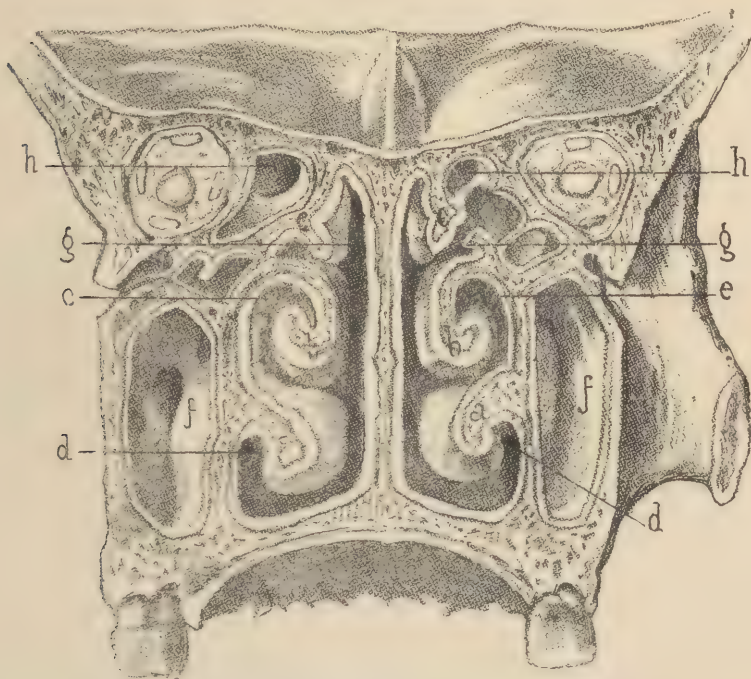
of the turbinated bones are plexuses of blood-vessels out of all proportion in number and size to those ordinarily found in mucous membrane. It appears from the researches of Dr. John N. Mackenzie that the spongy character of this tissue attracted attention in the year 1656, being mentioned by Rolfinck. After Rolfinck, other observers (Schneider, Ruppert, Duvernoy) made special advances in the appreciation of this peculiar tissue. The first distinct announcement that the turbinated tissue is true erectile tissue was made by Cruveilhier in 1845. The first careful anatomical investigation was made by Kohlrausch in 1853, who described as existing in the deeper layer large venous sinuses. Hyrtl and Kölliker made the same observations. Twenty years later, Dr. Bigelow, of Boston, published a masterly paper containing drawings and demonstrations of the spongy erectile nature of these turbinated bodies. (See Fig. 15.) Since these

FIG. 13.



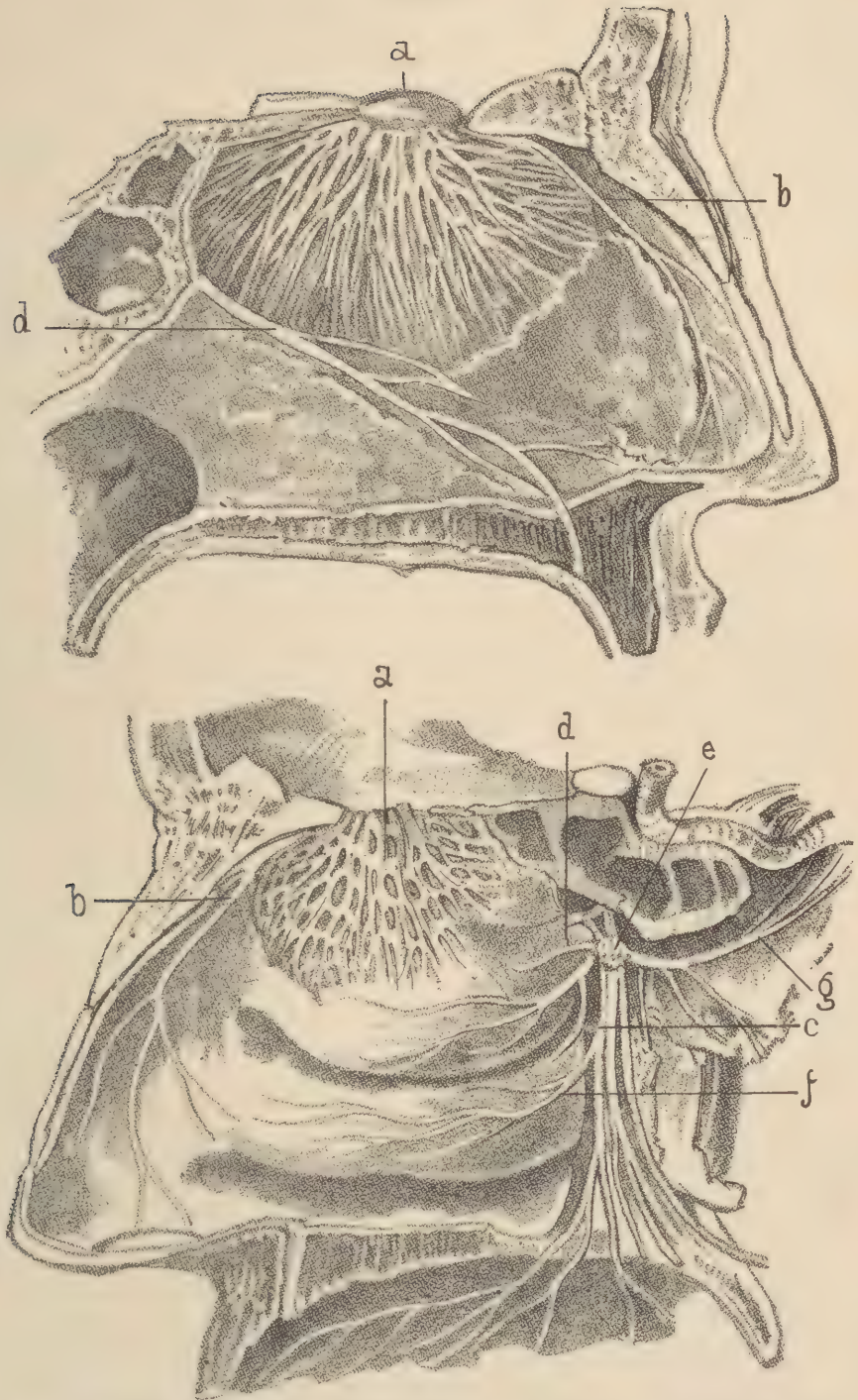
a, superior turbinated bone; *b*, middle turbinated bone; *c*, inferior turbinated bone; *d*, inferior meatus; *e*, middle meatus, communicating with *f*, maxillary sinus and *g*, infundibulum; *h*, superior meatus, communicating with *i*, posterior cells of the ethmoid; *j*, septum separating the two nasal fossae; *k*, *k*, orbital cavity; *l*, *l*, zygomatic cavity. (Hirschfeld.)

FIG. 14.



a, *a*, inferior turbinated bones; *b*, *b*, middle turbinated bones; *c*, *c*, superior turbinated bones; *d*, *d*, inferior meatuses; *e*, *e*, middle meatuses, communicating with *f*, *f*, maxillary sinuses; *g*, *g*, superior meatuses, communicating with *h*, *h*, posterior cells of the ethmoid. (Hirschfeld.)

FIG. 16.



a, a, distribution of the olfactory nerve in the lining membrane of the external and internal wall of one of the nasal fossae; *b, b*, ethmoidal filament of the nasal ramification of the ophthalmic branch of Willis; *c, d*, sphenopalatine nerve, external and internal, both given off from *e*, sphenopalatine ganglion; *f*, anterior palatine nerve supplying the lining membrane of the inferior turbinated bone; *g*, Vidian nerve supplying the naso-pharyngeal nerve for the mucous membrane of the posterior and upper part of the nasal fossa and of the Eustachian tube. (Hirschfeld.)

observations of Bigelow were made, this structure has been known as the turbinated corpora cavernosa. The injection of this tissue was made directly into the veins while fresh and then dried. The accompanying cut graphically illustrates the spongy or erectile tissue of the lower and middle turbinated bones. In the year 1884, Zuckerkandl published an exhaustive study of the anatomy of the nose. His work, since this publication, has been accepted as classical. The results of his investigations, succinctly given by Bosworth, are: "that the mucous membrane covering the turbinated bones consists of connective tissue, the upper surfaces covered with flat epithelium, the deeper layer forming the periosteum; between these two layers are found lymph-tissue freely distributed and probably lymph-glands. Tubular mucous glands remarkable for their length are found penetrating the mucous membrane to the periosteum. Within this lymphoid structure we have abundant venous plexuses which he calls 'swell-bodies' (schwellkörper); surrounding the venous plexuses a great quantity of unstripped muscular fibre is distributed. These swell-bodies, according to Bresgen, are distributed in the following manner: one plexus over the lower turbinated body, one along the border of the middle turbinated body, and one at the posterior extremity of each of the turbinated bodies. The distribution of the venous capillaries is so intimately associated with these swell-bodies that their anatomy is given here. The capillaries are divided into three sets; one being distributed to the surface, another to the glands, and the third to the periosteum. The capillaries distributed to the surface, together with the superficial gland capillaries, form loops which empty into the veins. The deeper gland capillaries and the capillaries of the periosteum pass into veins and form the swell-bodies. The blood is then conveyed by venous channels in the periosteal portion of the membrane to five distinct plexuses; one going to the veins of the face, a second to the veins of the cranium, a third to the orbit, a fourth to the soft palate, and the fifth to the hard palate."

The Nerves.—The nerves distributed to the mucous membrane of the nasal chambers are the nasal branches of the ophthalmic, the superior maxillary branch of the trigeminus, branches from Meckel's ganglion, and the olfactory,—the nerve of the special sense of smell. (See Fig. 16.)

The nasal branch of the ophthalmic enters the nasal cavity through a slit beside the crista galli and divides into an internal and an external branch. The internal branch is distributed to the mucous membrane of the anterior part of the septum; the external branch descends in a groove on the inner surface of the nasal bone, and supplies, by a few filaments, the mucous membrane as low down as the lower turbinated bone, then becomes cutaneous, passing out at the junction of the upper lateral cartilage of the nasal bone, and supplies the tip of the nose with sensibility. The branches of the superior maxillary nerve (the anterior palatine) supply the sensibility to the mucous membrane of the inferior meatus and inferior turbinated bone. The offshoots from Meckel's ganglion enter the nasal cavity through the sphen-

palatine foramen, and divide into two branches, the superior nasal and the naso-palatine. The superior nasal supplies the mucous membrane covering the superior and middle turbinates; it also sends filaments to the upper and posterior part of the septum and to the mucous membrane of the posterior ethmoidal cells. An anastomosis with a branch of the anterior palatine and superior nasal, in the antrum of Highmore, is called the ganglion of Bochdeleek. The naso-palatine supplies the middle portion of the septum, and afterwards descends along the septum and anastomoses with the anterior palatine after it has penetrated through the hard palate. The great superficial petrosal and the carotid branches of the sympathetic unite and form the Vidian nerve, which passes through the Vidian canal. The distribution of the Vidian is the same as that of the branches from Meckel's ganglion. The olfactory nerve supplies the nasal chambers with the special sense of smell. It has its origin in three roots: an external root, beginning in the deep substance of the middle lobe of the cerebrum; a middle root, from the carunculum annulare; and an internal root, from the inner and posterior part

of the anterior lobe. The union of these three roots forms a flat band which passes forward along the base of the brain until it reaches the upper surface of the ethmoid plate; at this point it expands into a bulb called the olfactory, which gives off from fifteen to eighteen branches on either side, which, penetrating through the cribriform plate by as many small openings, are distributed to the mucous membrane covering the superior turbinated bone, the upper third of the middle turbinated bone, and the upper third of the septum. (See Fig. 16, *a, a.*) They end in minute thread-like filaments, which pass to the surface of the membrane between the epithelial cells. Before these filaments reach the surface of the mucous membrane, minute bulbous expansions are found, known as olfactory cells. (See Fig. 17.) The blood-vessels supplying the nasal and accessory cavities are branches from the ophthalmic and branches from the internal maxillary.

FIG. 17.
The olfactory
cells in man.
(Max Schultze.)



The ophthalmic branches—the anterior and posterior ethmoidal—supply blood to the ethmoidal cells, frontal sinuses, and roof of the nose. The internal maxillary branches (spheno-palatine) are distributed to the mucous membrane of the septum and to the turbinated bodies. The alveolar branch supplies the lining membrane of the antrum of Highmore.

The Lymphatics.—The lymphatics, after forming a superficial net-work, terminate in two trunks which pass near the Eustachian tube and enter into glands in the lateral wall of the pharynx.

PHYSIOLOGY OF THE NOSE.

The functions performed by the nasal cavities are greater in number and variety than was believed by earlier physiologists, in whose opinion the sense

of smell embraced all that was understood as rightfully belonging to the nose. Olfaction now occupies a less prominent position as a function of the nasal cavities than do some others known to be of equal if not of greater importance. The functions now recognized are: 1, respiration; 2, olfaction; 3, the office of resonator to the voice; and, 4, the office of regulator of the aeration of the middle ears.

The respiratory function, in which are included the filtering, warming, and moistening of the inspired air, is carried on through that portion of the nasal chambers called the respiratory tract, embracing the inferior and middle meatuses.

Filtering the inspired air must be considered as of secondary importance to warming and moistening it. The hairs at the entrance of the vestibule offer resistance to the passage of coarser material, while the more delicate task of retaining such foreign matter as may escape the vestibule is effectively accomplished by the cilia and also by the moistened surface of the mucous membrane.

The function of warming the inspired air as it passes through the nasal chambers is one of the most important offices held by the respiratory tract, and that it is done, and that most efficiently, is now an established fact. The respiratory region, anatomically considered, is especially endowed for this end. The unique arrangement of the vascular supply of the turbinated tissue, added to the ability of this tissue to become automatically surcharged with blood under physiological demands, renders the warming of air of a lower temperature an easy and rapid process. Considering the great surface of mucous membrane spread out in such an efficient manner in so small a space, and added to this the great columns of warm blood in it, it can readily be seen how the air is warmed as it passes through the nasal meatuses on its way to the lower respiratory regions. That it is sufficiently heated for *all* respiratory purposes is not yet completely demonstrated, although recent investigations appear to show conclusively the ability of the nasal chambers to perfectly warm the inspired air-current; but the amount of warming must be considered at least sufficient to render the air acceptable to the lower respiratory organs. Under the head of the respiratory function, the ability of the turbinated bodies to supply moisture to the inspired air is of first importance. The view advanced by Bosworth in 1885, and confirmed, at least in part, by later experiments, is that the turbinated bodies, by transudation of serum through the walls of the capillary canals, so abundantly distributed in these bodies, supply to the inspiratory current of air sufficient moisture for *all* respiratory purposes. The experiments of Aschenbrandt and Kayser show clearly that the turbinated bodies give off as much as five hundred grammes of moisture in twenty-four hours, which is said to be sufficient for all respiratory necessities, putting the inspiratory current in a physiological condition for its reception by the air-cells of the lungs. The acceptance of this view lessens greatly the importance heretofore given to the respiratory tract *below* the nasal chambers as a medium through which

the air received moisture. In either case the nasal chambers appear to hold an all-important relation to the inspiratory current, not only in supplying heat, but also in supplying moisture in great abundance.

The function of the nose in phonation, in giving individuality and resonance to the voice, holds an important position in the economy. After the tone has been produced in the larynx by the vibrations of the free edge of the vocal bands, set in motion by the expiratory blast, the tone is amplified in the surrounding air and then modified by the palate, pharynx, oral cavity, tongue, lips, and nasal cavities. The character or individuality of the voice is given to it by the manner in which the sound-waves are influenced by the oro-pharynx and the nose. If the vibrations are interfered with in their passage to or through the nasal cavities, a lack of resonance is at once apparent. Certain vowels are formed without the aid of the resonant chambers of the nose, but a nasal influence is transmitted to them through the medium of the hard palate; in the case of consonants, the palate does not shut off the naso-pharyngeal cavity, but hangs free and allows the sound-waves to pass upward to become amplified and modified by the nose. The head-tones are also dependent upon the nasal resonant chambers for their perfection. Articulate speech soon becomes wearisome if the nasal chambers are obstructed; hence even ordinary speech is dependent upon a physiological state of the nasal chambers. *The olfactory region* of the nasal fossæ is that portion in which the numerous divisions of the olfactory nerve are distributed, and is devoted to olfaction. There are several conditions necessary to render the sense of smell efficient in the appreciation of odors. There must be contact between the odorous particles and the mucous membrane; the mucous membrane must be sufficiently moistened to dissolve the odorous particles so as to affect the terminals of the nerves distributed to the mucous membrane; the nasal chambers must be patulous, to allow a free access of atmosphere carrying these particles; and the olfactory centres must be free from disease. These conditions being present, olfaction takes place in the following manner: infinitesimal odorous particles floating on the air are carried into the nasal fossæ up to the olfactory area, and, impinging against the moist mucous membrane, are held fast and dissolved; coming in contact with the hairy terminations of the filaments, they excite an influence which is transferred along the branches and conveyed to the olfactory centres, and through them the subjective sensation of odor is appreciated. This generally-accepted theory is known as the "corpusecular theory." Scientists have been fond of speculating upon this function of olfaction, and many curious, ingenious, and plausible theories have been published. To quote briefly: Liégeois maintains that the impinging of these odorous particles upon the mucous membrane in contact with the nerve-terminals "mechanically irritates" the nerves and produces the sensation by this means; Graham, that by means of oxidation the odorous particles produce the appreciation of odor, odorous particles being readily oxidized, inodorous being non-oxidizable; Ramsay,

that there is a close relationship between the molecular weight of bodies and their odor: his theory is that olfaction is the result of molecular vibration, odorous bodies having very rapid vibrations, while inodorous molecules have too slow vibrations to affect the olfactory nerves; Tyndall found bodies to be odorous in proportion as they could absorb heat; and Ogle has evolved a theory, supported by a number of ingenious clinical observations, that the pigment in the nasal fossæ secreted by Bowman's glands takes an important part in olfaction. And he draws an analogy between sight, hearing, and smell, that as the pigmentation of the choroid layer and the aural ampullæ serves as a vehicle for the reception of the waves of light and sound, so does the pigment in the nose simply act as a vehicle for receiving the waves of odor. The relation of the nasal chambers to the *auditory apparatus* is an intimate one. The pneumatic function of the middle ear is carried on through the Eustachian tube. The volume and density of the air carried through the Eustachian tube are regulated by the supply received through the respiratory tract of the nasal chambers. The Eustachian tube may be considered as simply a conduit through which the atmosphere passes to the middle ear, the supply being regulated by muscles acting as valves in the distribution. If from any cause the nasal passages become occluded, the supply of air is cut off from the middle ear, and the sense of hearing is quickly influenced. To maintain a normal functional activity of the sense of hearing, a full and free supply of air through the nasal chambers is essential.

THE ANATOMY OF THE NASO-PHARYNX.

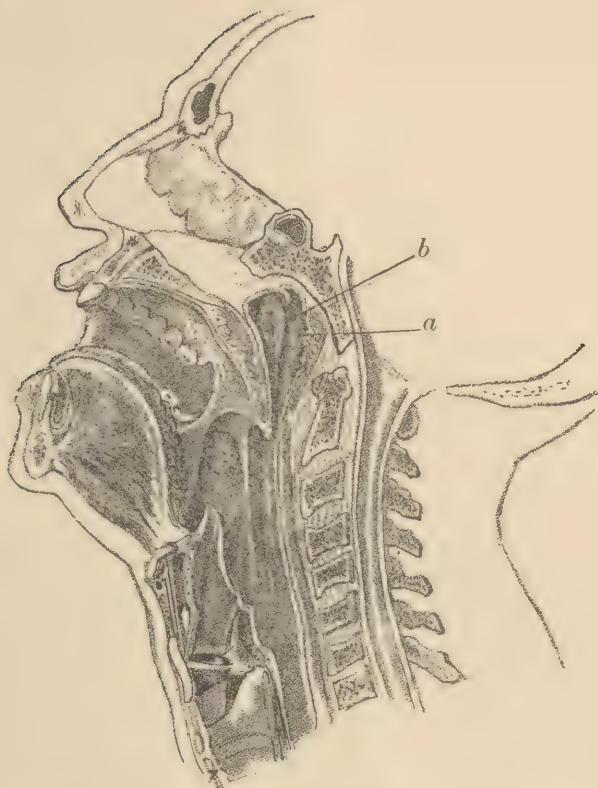
The pharynx is that portion of the alimentary tube which extends from the basilar process of the occipital bone above to the intervertebral cartilage of the fourth and fifth cervical vertebræ below. It is continuous above with the ear, in front with the nasal and oral cavities, and below with the œsophagus and larynx. It is a flattened membranous tube of varying diameter in the different portions,—wider above than below, and slightly concave in front. The pharynx is freely movable over the cervical spine, thus permitting the various movements which take place in swallowing and respiration. It is in relation behind with the pre-vertebral muscles, which are covered by a strong aponeurosis, and with the retro-pharyngeal cellular tissue, which intervenes between the pharynx and the aponeurotic layer; at the sides, with the blood-vessels of the neck (carotid and internal jugular), the eighth pair of nerves, the sympathetic nerve, the chain of lymphatics, and the ganglia; in front, with the nasal fossæ, the soft palate, the isthmus of the fauces and dorsum of the tongue, and the posterior aspect of the larynx. The greatest length of the pharynx in the adult is about five inches. It is attached above to the basilar portion of the occipital bone, to the sphenoid bone, and to the basilar fibro-cartilage; in front and above it is attached to the vomer on the middle line; at the sides, to the internal pterygoid plates of the sphenoid bone; below, to the horizontal plates of the palatal bones;

and behind, to the anterior surface of the five upper cervical vertebræ with their fibro-cartilages. The pharynx consists chiefly of a fibrous framework lined with mucous membrane containing a complex muscular layer with blood-vessels and nerves. "The fibrous structure of the pharynx forms a complete investment, which serves to maintain its form, and is very tough and strong, and has the fibres of the several muscles attached to it."

There are three divisions of the pharynx, commonly known as—first, the naso-pharynx, extending from the basilar process of the occipital bone downward to the free edge of the soft palate; second, the oro-pharynx, which includes that portion of the tube extending from the free edge of the soft palate downward to a horizontal plane on a level with the greater horn of the hyoid bone; and, third, the laryngo-pharynx, which begins at the lower edge of the oro-pharynx (greater horn of the hyoid) and extends down to the lower edge of the cricoid cartilage. These three divisions of the pharynx, although somewhat arbitrarily mapped out, render the study of the complex anatomy of the pharynx much clearer and make possible a succinct description of it. The naso-pharynx—the widest expansion of the pharyngeal tube—gets its name from its near relationship to the nasal chambers. (Fig. 18.) The naso-pharyngeal cavity is quadrilateral in shape, and wider from side to side than from before backward. The dimensions of the space are, according to Luschka, from before backward three-fourths of an inch, the same for the vertical diameter, and its width one and three-eighths inches. This cavity lies behind the posterior nares and part of the oral cavity; it is bounded above (its roof or vault) by the basilar process of the occipital bone and a part of the posterior portion of the body of the sphenoid; below, by an imaginary plane horizontally placed opposite the free edge of the soft palate; in front, by the oval openings of the posterior nares and the free surface of the vomer, which presents a much broader surface above, where it articulates with the sphenoid bone, but is quite narrow below, where it is joined to the hard palate; behind, by the bodies of the vertebræ as low down as the arch of the atlas; from the arch of the atlas the posterior wall curves forward as it ascends.

The lateral walls are defined chiefly by the cartilaginous portion of the Eustachian tubes. The form of the naso-pharyngeal cavity has been aptly likened to the hood of a carriage. There are four openings in this naso-pharyngeal cavity,—the two openings of the nasal chambers and the two orifices of the Eustachian tubes. The cavity of the naso-pharynx varies greatly in different individuals, as to both form and capacity. The cartilaginous portion of the Eustachian tube, which leads from the naso-pharynx to the middle ear, is an ovoidal cartilaginous tube, which presents in the anterior and lower portion of the lateral wall; it lies on a level with the posterior nares, and is about one-fifth of an inch below the base of the skull. The orifice of the Eustachian tube remains closed in a state of rest, but is opened during functional activity of the fauces. The pharyngeal portion

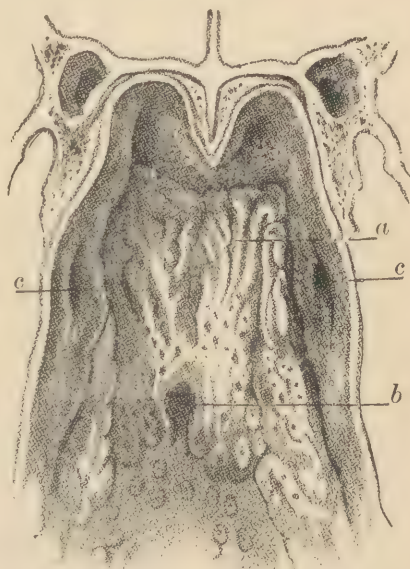
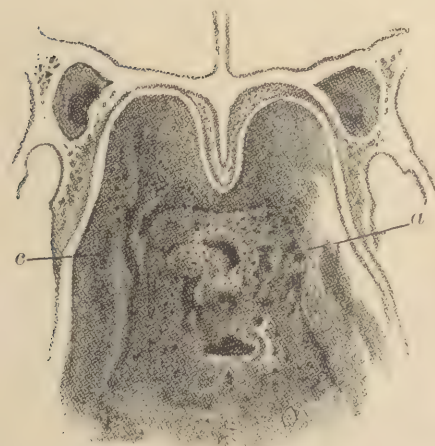
FIG. 18.



a, naso-pharyngeal cavity; *b*, pharyngeal orifice of the Eustachian tube. (Luschka.)

FIG. 20.

FIG. 19.



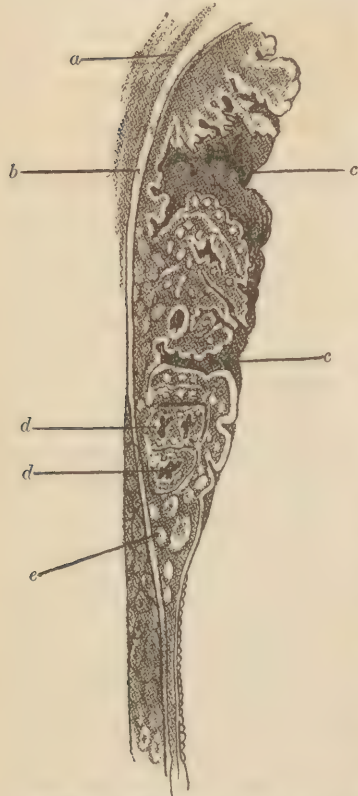
a, pharyngeal tonsil; *b*, orifice of the bursal sac in the pharyngeal tonsil; *c*, orifice of the Eustachian tube. (Luschka.)

of the Eustachian tube is marked by a funnel- or trumpet-shaped orifice which is known as the pharyngeal orifice, whose dimensions are two-fifths of an inch in vertical, and one-fifth of an inch in transverse diameter. The rim or border of this orifice is a well-defined cartilaginous ridge formed by the cartilage which enters into the formation of the tube. This ridge is well marked posteriorly and above; in front it is less prominent, while below the cartilaginous framework is absent. The mucous membrane of the naso-pharyngeal division of the pharynx is applied to the entire internal surface of it, and is continuous with all the openings into it. It is more adherent in the naso-pharynx than in the lower divisions of the pharynx. The structure of the mucous membrane is partly fibrous and partly connective tissue. It is less dense in this portion than lower down, and contains an abundance of glands. It is lined with cylindrical and ciliated epithelium, and varies in color in different portions. The mucous membrane, as it is reflected on the upper extremity of the cartilaginous portion of the Eustachian tube, forms a fold of membrane which extends to the border of the posterior nares, and from its posterior extremity another fold extends to the posterior surface of the velum pendulum palati. Between the orifices of the Eustachian tubes and the posterior wall of the pharynx is a crescent-shaped depression which is known as the "fossa of Rosenmüller." This fossa is irregular in shape, deeper in some subjects than in others, and broader above than below. The *depth* of this fossa is largely governed by the height or prominence of the cartilaginous eminence of the Eustachian tube. The glands situated in the naso-pharynx are of two kinds, conglomerate and follicular. The conglomerate glands are found in greatest number at the posterior border of the Eustachian tubes and on the pharyngeal surface of the soft palate, where they are clustered together. The follicular glands are collected together in the roof or vault of the pharynx, and form the "tonsil of Luschka" (Figs. 19 and 20), also known as the pharyngeal tonsil or the third tonsil. This collection of follicles has been spoken of by Luschka as an aggregated acinous gland. (Fig. 21.) The "tonsil of Luschka" is about one-fourth of an inch in thickness and situated between the orifices of the Eustachian tubes, sometimes extending the whole width of the pharynx to the fossa of Rosenmüller, and even encroaching upon the eminences surrounding the Eustachian tubes. It appears as a soft cushion covered with round elevations, and is traversed by fissures in various directions. At the lower portion of the pharyngeal tonsil, in the median line, a small opening is sometimes present which leads into a sac about three-fourths of an inch long and one-fourth of an inch wide, known as the pharyngeal "bursa," the name being given to it by Luschka from a term already used by Meyer in description of the pharynges of certain mammalia. The anterior wall of this bursal sac is covered with glandular tissue, while the posterior wall is joined by a ligament to the basilar process of the occipital bone. Some observers deny the existence of this sac as a distinct anatomical structure, holding that this bursa is simply the median fissure of a

normal pharyngeal tonsil, the fissure being the result of adhesion of the superficial layers of the glandular tissue.

The muscles concerned in the functions of the naso-pharynx are chiefly the dilators of the mouth of the Eustachian tubes. They are the *tensor palati*, the *levator palati*, and the *palato-pharyngeus*. The muscle acting most prominently as a dilator of the tube is the *tensor palati*. This muscle, called by otologists speno-salpingo-staphylinus, or dilator tubæ, arises from the base of the internal pterygoid plate of the sphenoid, the scaphoid fossa, and the cartilaginous portion of the Eustachian tube in its entirety. From its origin it passes downward, forward, and inward, winding around the hamular process of the sphenoid, to be inserted into the soft palate. Its function is to draw the anterior cartilaginous margin of the tube downward and forward, enlarging the calibre of the tube. Next in importance in

FIG. 21.



VERTICAL SECTION OF NORMAL PHARYNGEAL TONSIL. (Luschka.)—*a*, basilar fibro-cartilage; *b*, internal pharyngeal fascia; *c*, *c*, lacunæ of tonsil; *d*, *d*, section of single capsule, with follicles; *e*, acinous mucous glands.

dilating the tube is the *levator palati*, a long rounded muscle arising from the petrous portion of the temporal bone and from the cartilaginous portion of the Eustachian tube; passing downward and inward from these attachments, it spreads out into a broad tendon and is inserted into the soft palate in its median line, where it is joined by the same muscle of the opposite side. The fibres of this tendon blend with the mucous membrane of the soft palate. The office of this muscle is to lift the lower edge of the closed tube into position, so that its lateral walls open or separate and render the mouth of the tube patulous. The *palato-pharyngeus* may be considered as an adjunct of the *levator palati*. The origin of this muscle is in the soft palate, the posterior portion of the hard palate, and the cartilaginous tube. The fibres pass downward to the thyroid cartilage, the fibres of the opposite muscles interlacing with it over its insertion in the thyroid. Its action is to fix or steady the cartilaginous portion of the Eustachian tube and thus increase the function of the *levator palati*.

The blood-vessels supplying the naso-pharynx with arterial blood are branches derived from the internal carotid (ascending pharyngeal), branch of the facial (ascending palatine), and branches from the internal maxillary, palatine, and sphenopalatine. The ascending

pharyngeal supplies the greater portion of the naso-pharynx and of the Eustachian tubes. The other branches above mentioned are chiefly terminal twigs which are distributed anteriorly and laterally behind and above the openings of the posterior nares,—all anastomosing freely with one another. The veins, after collecting into a dense plexus in the deeper layers, terminate in the internal jugular. The lymphatics form a net-work in the mucous and muscular layers, and terminate in glands at the base of the skull. The nervous supply is derived chiefly from the second division of the fifth pair; also branches from the glosso-pharyngeal and vagus are distributed to this region.

THE PHYSIOLOGY OF THE NASO-PHARYNX.

The functions of the naso-pharynx are closely allied to the functions of the nasal fossæ, of which it is really a part. The naso-pharynx, in common with the nasal chambers, assists in maintaining respiration, olfaction, and audition, and in modifying the vocal sound; and it follows that any change in the contour of the naso-pharyngeal cavity or any encroachment on this space by morbid processes at once gives rise to changes in breathing, in hearing, and in the resonance of the voice. To the theory that the chief function of the naso-pharyngeal cavity is to secrete fluid to render the pharynx smooth and to lubricate the bolus of food, the objection suggests itself that there appears no reason for the usurpation of the functions of the salivary glands by this cavity; nor can the normal secretion of the tonsil of Luschka be considered as material in quantity, or sufficient to do more than lubricate the mucous membrane to a limited extent. If the secretion from the tonsil of Luschka be of so great importance, it must be only during childhood, for in adult life atrophy of this gland takes place, and its function must then be vicariously performed or the adult economy seriously disabled.

METHODS OF EXAMINATION AND DIAGNOSIS OF DISEASES OF THE NOSE, NASO-PHARYNX, AND LARYNX.

BY SAMUEL G. DABNEY, M.D.,

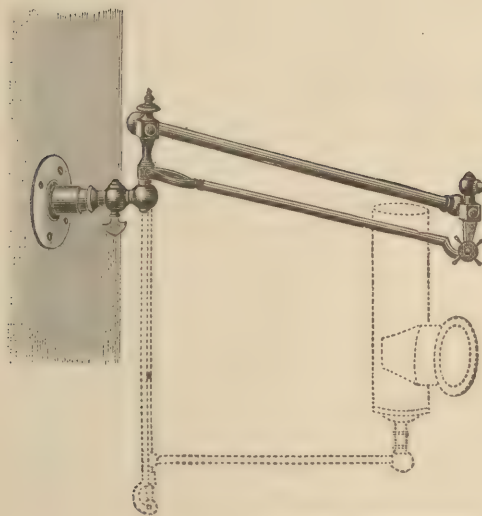
Professor of Physiology and Clinical Lecturer on Diseases of the Eye, Ear, Throat, and
Nose in Hospital College, Louisville, Kentucky.

To examine the upper air-passages, we reflect light either directly on the part to be inspected, as into the anterior of the nose, or upon a mirror so placed as to receive the image of this part, as in the case of the nasopharynx and larynx. For purposes of illumination ordinary daylight sometimes suffices, and sunlight may be used to great advantage when it is obtainable. Usually, however, we depend upon artificial light; this may be either from gas or a kerosene lamp, from the Welsbach burner, from an electric lamp, or from the oxy-hydrogen flame. Gas-light is generally the most convenient and amply sufficient.

Fig. 1 shows a useful adjustable gas-bracket, and Fig. 2 is a Mackenzie's condenser fitted on it to concentrate the rays of light into a cylinder. The Welsbach burner furnishes an excellent means of illumination, and is growing in popularity. It can be fitted to any gas-fixtured, and is not expensive. The light is obtained from an incandescent hood which surrounds the flame. The composition of this hood is patented. It is claimed that each one will burn for about two thousand hours—actually burning—and a new one can be put on with very little inconvenience or cost. Electric light may be used either reflected from an illuminator worn on the forehead or as an incandescent lamp carried into the throat. Cresswell Baber has found the combination of an electric light in the throat, back of the palate, and light reflected into the anterior of the nose useful in nasal examination. For bedside examination a kerosene lamp or even a candle answers very well. It is an advantage to have the room darkened when an artificial light is used. The color of the part examined will vary somewhat with the kind of light. It will appear redder under gas or an oil lamp illumination than under electric or the Welsbach light. To direct and concentrate the light, a concave mirror is used as a reflector; this mirror should have a focal distance of from eight to fourteen inches and a perfora-

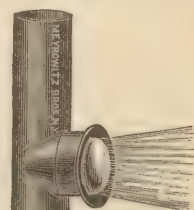
tion in the centre. The size I prefer is three and a half inches in diameter, and has a focal distance of fourteen inches; it is attached by a ball-and-

FIG. 1.



Mackenzie's light-condenser and gas-bracket.

FIG. 2.



socket joint to a frontal pad, to which are fastened an elastic head-band and smaller pads to rest on the nose. (See Fig. 3.)

I have found this nasal support to steady the mirror and make it more comfortable to wear. The mirror should be so worn that its central perforation is before the pupil of the examiner's eye; it thus serves to shield him and gives him the advantage of looking through the centre of the reflected cone of light. It may also be worn on the forehead. For office use various forms of fixed apparatus for illumination and reflection are employed with advantage. I have used a Beseler's laryngoscope for several years. (Fig. 4.) I now

FIG. 3.



Schroetter's head-mirror.

have a Welsbach burner in it, and use natural gas from the wells in Meade County, Kentucky; the light is powerful and white. This fixed apparatus permits freedom of movement on the part of the operator; it requires that the patient's head shall be kept steadily in one position. In any case the

physician should accustom himself to the mirror worn on the forehead, as this must often be employed for examination outside of the office. Though no special chair is necessary for examining the nose or throat, one with a shallow seat and a straight high back has the advantage of preventing a patient from drawing back out of reach.

FIG. 4.



BESLER'S LARYNGOSCOPE.—*a*, concave mirror of 24 inches focal distance (should have a central perforation); *b*, rod for carrying mirrors; *c*, movable end of condenser for directing the light; *d*, plane mirror; *e*, concave reflector of polished metal; *f*, within the cylinder a convex glass.

A head-rest is sometimes desirable for examinations and often for operations. A movable dental head-rest has been very useful to me; it can be made higher or lower, carried backward or forward, to the right or left, and can be easily adjusted to any chair. For an examination with the head-mirror, the patient should be seated with the light about on a level with his ear and a little to one side of him; the physician, sitting opposite, should adjust the mirror steadily and comfortably to his head, and so direct it as to concentrate the light on the spot desired.

As the ease and completeness of our examination will greatly depend on the co-operation of the patient, we should be especially careful to avoid causing fear or embarrassment.

It is often well to assure timid patients that only an examination is intended, as the sight of instruments and their introduction into the nose or throat excite the fear of an operation.

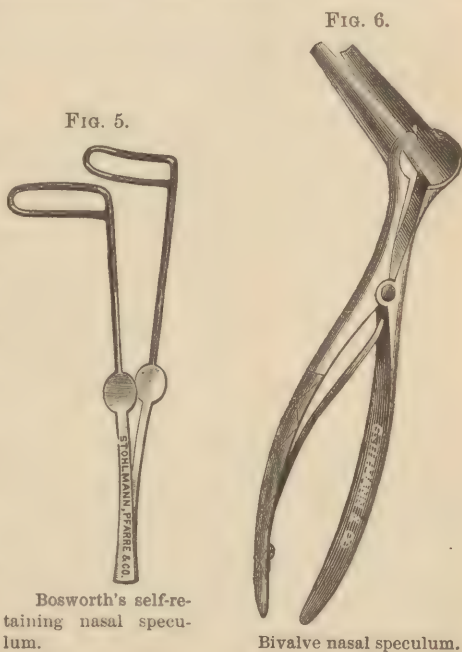
It may not be out of place here to remind the reader of the necessity for scrupulous cleanliness of all instruments to be used about the nose or throat. An arrangement I have found convenient is a small gas stove with a pan of boiling water on it under my table; into this every instrument is immediately laid after its use. According to Gerster, this is the very best disinfectant for instruments, and liability to rust may be removed

by adding one heaping tablespoonful of common washing-soda to the quart of water. With these preliminary remarks, which apply both to nasal and to laryngoscopic examination, we pass to the consideration of the methods of examination and diagnosis of diseases of the nose, naso-pharynx, and larynx respectively.

Anterior rhinoscopy is the name given to an examination by means of light directed into the anterior nares. To allow thorough illumination, the nostril must be dilated by a speculum, but much can often be seen by simply raising the tip of the nose with the finger and directing light into first one nostril and then the other. It is sometimes desirable to use a nasal speculum that is self-retaining, but I have not found one which could be worn with entire comfort to the patient, nor do I consider its advantage great.

The accompanying illustration shows the self-retaining speculum used by Bosworth (Fig. 5.) The bivalve speculum (see Fig. 6), opened by pressing on the handles, is the one I habitually use. Whatever instrument be chosen, we should be careful not to insert it too far, not farther than the lateral cartilage, and not to press its end on the septum, as this is always painful.

Though it will often be necessary to cleanse the nose by sprays or otherwise and to apply cocaine before we can make a complete examination, yet our first inspection should be without cleansing or cocaine, as it is often important to note the character and quantity of the nasal secretion, the turgescence of its mucous membrane, the presence of any sensitive spots, and other conditions which a detergent spray or cocaine would probably remove. Having inserted the speculum and directed the light through it into the nose, we direct the patient to hold his head first horizontally or a little depressed. We thus inspect the lower part of the nasal chamber and observe the condition of the septum, the floor and inferior meatus, and the inferior turbinated body. Having the patient gradually move his head backward, we cast our light on the middle turbinated and the septum opposite, and, still higher, usually get a glimpse high up and far back of the superior turbinated. The lower turbinated should appear as a palish-red projection running along the outer wall of the nose, with the inferior meatus between it and the nasal floor; a little higher up, and separated



from the lower turbinated by the middle meatus, is seen the middle turbinated body, rather paler in color and nearer the septum. Only a small portion of the superior turbinated can usually be seen. By having the patient move his head right and left, a more complete view of the lateral wall and septum can be obtained. The septum should be vertical and should separate more or less symmetrically the right and left nasal passages. It is very common, however, to find some deviation towards one side, even in a healthy nose; only when sufficient to materially obstruct the passage of air can such a deflection be considered abnormal.

There is often a prominence on the septum, just opposite the middle turbinated bone, of glandular structure, to which Cresswell Baber has given the name of *tuberculum septi*.

Should we find the nose so coated and full of secretion as to conceal the character of the underlying mucous membrane, a solution made by dissolving one of Seiler's antiseptic nasal tablets in four tablespoonfuls of water will be a useful cleansing spray. A solution of this strength represents the following formula:

Sodium bicarbonate,
Sodium borate, aa one ounce;
Sodium benzoate,
Sodium salicylate, aa twenty grains;
Eucalyptol,
Thymol, aa ten grains;
Menthol, five grains;
Oil of gaultheria, six drops;
Glycerin, eight and one-half ounces;
Alcohol, two ounces;
Water to make sixteen pints.

If there is much puffiness over the turbinated bodies, gentle pressure on them with a probe will help us to decide whether this is due to a genuine hypertrophy or to temporary turgescence. The pitting made by the probe will fill up instantly on removing it from hypertrophy, but will remain a little longer in case of venous turgescence. But this point, and indeed most others, can be more satisfactorily determined after the application of cocaine; only we must bear in mind that examination for sensibility, whether it be of hyperæsthetic areas or of new growths, should be made before using it. A four-per-cent. solution of muriate of cocaine is usually sufficient. It is often applied as a spray, and much stronger solutions are sometimes employed. I prefer to apply it on a pledget of absorbent cotton and leave it in from three to five minutes. We can thus localize its effect more exactly, and are less apt to have it get into the naso-pharynx, where it is often very disagreeable, producing a "stuffy" sensation and a constant inclination to hawk. Moreover, we are less likely to have any unpleasant systemic effect from the cocaine applied in this way than from a spray. Cocaine is useful both for its anæsthetic influence and because, by contracting the capillary vessels, it shrinks turgescient tissue.

Should any decided thickening of the membrane over the turbinated bones remain, as a rounded or irregular cushion more or less obliterating the outline of the underlying bone, we have proof of hypertrophic rhinitis. Such thickening is often irregular, and is apt to be most marked about the anterior end of the bone and along its lower border, partially occluding the inferior meatus.

Over the anterior end of the middle turbinated the hypertrophy often takes on the appearance of myxomatous tissue and shrinks comparatively little under cocaine (Bosworth).

The density and degree of thickening should be examined with a probe. A pledget of cocaine should be carefully packed in at the lower edge of the middle turbinated, as this is frequently the place of attachment of polyps. The membrane covering this bone should also be thoroughly examined; it is often thickened, and by pressure on the septum causes much discomfort and occasionally reflex disturbance.

The frequent recurrence of polyps suggests diseases of the ethmoid, either on the surface or in its cells, and careful examination for this condition should be made with a probe.

A mucous membrane thin and dry and covered here and there with crusts, with a little pus often lying on the floor, indicates atrophic rhinitis; here, careful cleansing is a necessary preliminary to examination. Having observed the position and symmetry of the septum, we must further look for spurs or ridges on its surface, for ulcers or perforations, and for any local tenderness or swelling.

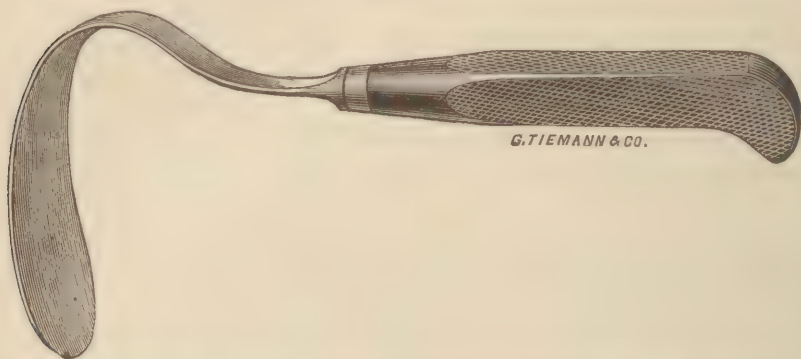
A little pus lying on the lower turbinated or between it and the middle suggests the presence of pus in the antrum; the nasal chamber should be carefully cleansed and the patient made to lie down with his head low and the affected side of his face uppermost; after a few minutes, if there is antrum disease, we shall find that more pus has emptied into the nose. An incandescent electric lamp fastened to a Türk's tongue-depressor may also be used to advantage after the fashion suggested by Heryng. The lamp being lighted in the closed mouth, a glow will be seen through a healthy antrum in a dark room, but will be less transmitted by one containing pus. This test, however, is not pathognomonic. Should a tumor of any kind be found in the nose, its point of attachment, consistence, tenderness, and vascularity must be carefully examined by the probe. A piece should also be removed, when possible, for microscopic examination. In this connection we should mention also the value of the microscope in establishing the diagnosis of diphtheria.

Any suspicious nasal membrane should be subjected to this test, and the presence of the Klebs-Löffler bacillus must be taken as valuable evidence of diphtheria.

In cases of epistaxis we should search for some rupture from which the blood comes; it will generally be found on the lower and anterior part of the cartilaginous septum. It is often valuable, too, to look for hyperæ-

thetic areas in the nose ; with this in view, we should gently touch with the probe the anterior part of the septum and of the middle and lower turbinated bodies and the posterior portion of the lower turbinated body and the septum adjacent.

FIG. 7.



Sass's tongue-depressor. (A smooth aluminum handle has the advantage of lightness and of being easily cleaned.)

To examine the naso-pharynx and posterior nares, the position of patient and observer should be that already described for anterior rhinoscopy, with the patient's head horizontal or a little depressed. To obtain a view of this space it is necessary that the tongue be kept down, the palate relaxed, and a mirror so placed back of the palate as to reflect the image of the parts above. Hence we need a tongue-depressor and a rhinoscopic mirror in addition to our reflector and light. The tongue-depressor I have found best is Sass's. (See Fig. 7.)

Its smooth surface makes it easy to clean ; its curve fits well to the tongue, and if the handle is long it may often be held by the patient without being in the operator's way. It is important to have several different-sized tongue-depressors. If the instrument is too wide it is apt to press on the gum and cause pain.

FIG. 8.



Folding tongue-depressor.

Fig. 8 illustrates a useful folding instrument convenient to carry.

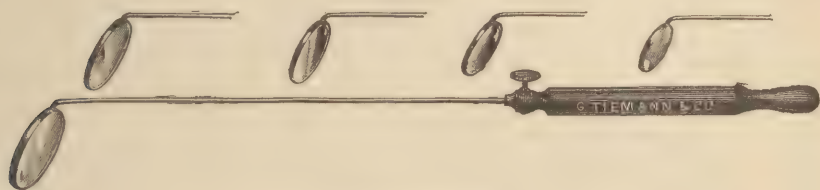
The rhinoscopic mirror should be from one-half to three-quarters of an inch in diameter, and attached to the handle at an angle of from 105° to 130° .

In Fig. 10 an instrument is represented to which mirrors of different sizes may be screwed on and the inclination of the mirror changed by pressing on the lever above the handle. In these respects, and because the angle of the handle keeps the observer's hand out of his view, it is convenient. The objection to it is that constant pressure from the thumb is required to hold the mirror at the right

inclination. Fig. 11 shows Jarvis's combined tongue-depressor and mirror.

In introducing the tongue-depressor we must be careful not to carry it too far back, or else the patient will certainly be made to gag; nor must we

FIG. 9.



Rhinoscopic mirrors.

press down the front part of the tongue so that its summit will rise up and obstruct the view, but so place the instrument that we have the tongue well under control. When it resists, gentle but firm pressure continued for a few seconds will often bring it into submission. With the tongue depressed and the light focussed at or near the uvula, we must next see that the palate is

FIG. 10.



Adjustable rhinoscopic mirror.

relaxed. Many persons, when the mouth is open and the tongue held down, draw up their palate and breathe through the mouth; they should be directed to breathe through the nose, and if this fails, to pronounce the French word "en," or to say "hang." The device recommended by Spencer Watson is as follows: "Direct the patient to breathe rapidly in

FIG. 11.



Jarvis's combined tongue-depressor and rhinoscope.

short gasps, and at the same time divert his attention from his throat and concentrate it on his chest movements." I have sometimes found this plan useful. In any case it is better not to make prolonged efforts, but brief and repeated ones. Tact and patience in the use of one of these methods or of several of them will usually succeed in making the soft palate relax,

and will allow a view of the naso-pharynx. Sometimes painting a solution of cocaine (four per cent.) on the fauces will be of great assistance, especially when gagging is induced by the introduction of the mirror. Finally, if the space between the soft palate and the pharynx be narrow it will be necessary to draw forward the palate. For this purpose White's palate

FIG. 12.



White's palate retractor, applicable in all cases except where upper teeth are gone or upper lip recedes.

FIG. 13.



White's palate retractor (lip-piece to go into the nostril), used where upper teeth are gone or upper lip recedes.

hook is the best. Dr. White is of the opinion that this instrument often fails to answer its purpose because it is not made accurately after the original. Bartlett, Garvens & Co., instrument makers of Richmond, Virginia, are recommended by him for this retractor.

Dr. Joseph A. White, of Richmond, Virginia, the inventor of this instrument, gives the following directions for its use: "Apply a little cocaine solution, two to four per cent., with a cotton-holder on the back of the soft palate. Of course a little of this is squeezed on to the pharynx. In a few moments depress the tongue gently, instructing the patient to breathe quietly, so as to relax the palate muscles. As soon as he does this, press the hook of the palate retractor gently against the soft palate, and, holding it there without traction, remove the depressor and tell the patient to close the mouth. As he closes the lips on the retractor (the teeth must not be shut tight) a long breath makes the palate come forward, and the bar of the retractor will at once push out of the mouth, as it were; the lip-piece is then run forward until it makes special pressure on the alveolar process and the hinge part is turned up. The patient is then told to open his mouth quietly whilst continuing to breathe. If he holds his breath he will gag; if he continues to breathe almost a perfect view of the post-nasal space can be gotten. It sometimes happens that at the first examination, whether from timidity or fright, the patient cannot do this; do not press the point; wait for the next visit; and I have never yet seen the patient, however irritable the throat, who could not be examined in this way with a little patience; and after it is once done there is never any more trouble."

Dr. White further suggests that, if the patient should complain of the wire making an uncomfortable traction on the soft palate, rubber bands should be slipped over the wire. These bands usually accompany the instrument, or can be obtained from the instrument makers. Though I have not used the palate retractor so universally as Dr. White, I have

found it a very useful addition to my means of examination, and it is generally conceded to be the best device we have for drawing forward the soft palate.

In a few cases it will be expedient to tie the palate forward. This can be done by passing a small rubber cord through the nose and bringing it out of the mouth and tying over the upper lip; or a longer cord may be used, one end being passed in through each nostril; both are drawn out through the mouth and carried one above each ear and tied behind the head. This is the plan advised by Bosworth, and attributed by him to Desgranges. It is well to smear the cord with vaseline or oil before introducing it. With the palate pendent and the tongue depressed, our next step is to introduce the rhinoscopic mirror. This must first be warmed by holding the glass surface towards the flame for a few seconds, to prevent the breath from condensing on the mirror and so obscuring the image. Before introducing we should try the metallic side of the mirror on our hand, to see that it is not too hot. Held in the hand like a pen, the mirror should then be carefully introduced with its reflecting surface upward to a point a little to one side of or, if there is room, beneath the uvula. Precaution must be taken not to touch the tongue or palate, for by so doing gagging will most likely be induced. Sometimes the mere sight of the mirror going in the mouth will make the patient gag; then it may be useful to have the eyes closed. Occasionally painting the throat with cocaine will be necessary; this plan is so much superior to the administration of bromides or holding ice in the mouth that they need hardly be mentioned. I recall one case, however, of a nervous lady in whom all attempts failed until a good dose of valerian was given, after which I found it easy to make a thorough rhinoscopic examination and to snare a post-nasal polyp.

The view obtained will depend on the position of the mirror (see Plate I., Fig. 1). Holding it at first with the reflecting surface nearly horizontal, we see the roof and the upper part of the posterior wall of the pharynx. In adults the roof usually appears as a smooth, rounded dome with pale-red mucous membrane; in some cases, just in the centre of the dome a narrow pointed depression is seen; in others, the roof and often the walls of this space are covered with a cushion-like glandular mass, in the lower central part of which an opening is occasionally but not generally to be seen. Tilting the mirror to a more nearly horizontal position, it reflects the posterior nares with the septum broad above and tapering below, dividing them; on the outer wall of each side the turbinated bodies appear as pale-red masses; the middle turbinated is seen best, and appears as a red projection separated from the septum by a well-defined space; beneath it is the upper part of the lower turbinated with the middle meatus between them of the same color, but nearer the septum, and with its lower part concealed from view; high up in the posterior nares appears the superior turbinated, lighter in color, —a thin shelf sloping upward and outward.

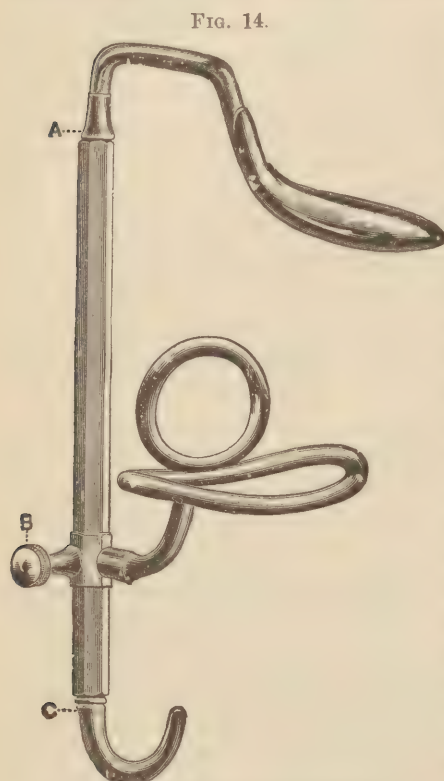
Turning the mirror a little to one side, we see the Eustachian tube, pale

red and hard-looking, with its funnel-like orifice seen in profile, and appearing as a slit of lighter color than the surrounding membrane; behind the tube and between it and the posterior wall of the pharynx is a depression known as the fossa of Rosenmüller.

Having thus briefly sketched the normal appearance of the naso-pharynx, attention must be directed to some of the changes observed in disease and their diagnostic importance. We should carefully note the character of the mucous membrane, whether smooth or thickened, its color and secretion, the presence of any ulceration, of posterior hypertrophies of the turbinated bodies, or of adenoid growths. Sometimes an œdematous condition of the

septum on either side is seen; sometimes polyps originating in the nose hang down into the naso-pharynx; and, finally, tumors, usually fibromata or fibro-sarcomata, may originate in this space itself.

A probe introduced through the nose and guided by the rhinoscopic mirror will be of great service in examining morbid conditions of the naso-pharynx. I find it also a very convenient way of applying cocaine to this locality. If a probe with a short curve at the end be wrapped with a little cotton soaked in a solution of cocaine and introduced through the nose, it can be turned in the naso-pharynx and a thorough application to its roof and walls be made. In this case the patient must hold the tongue-depressor or a self-retaining instrument be used. White's self-retaining tongue-depressor is useful for such purposes. (Fig. 14.)



White's self-retaining tongue-depressor.

With the probe introduced in this way, we should examine the attachment, vascularity, consistence, and tenderness of any post-nasal growth, should feel for dead bone whenever it seems indicated, and should determine whether any thickening at the posterior ends of the turbinated bodies is a real hypertrophy or a mere turgescence.

Palpation by digital examination is often our only means of examining the naso-pharynx in children, and sometimes is very useful in adults also. In a young child it is best to give an anæsthetic, preferably chloroform. The forefinger having been carried around the soft palate should seek the

septum, and, examining the condition of the nares on each side, should then be guided to the roof and walls, feeling carefully for the bunch-of-worms-like sensation of adenoid growths or the soft cushion of glandular hypertrophy. Should a tumor be found, its mobility, consistence, tenderness, place of attachment, and vascularity must, as far as possible, be ascertained.

Bosworth considers the free exit of a vaseline spray from one nostril when thrown into the other, proof of a clear naso-pharynx.

SYMPTOMS OF DISEASE OF THE NOSE AND NASO-PHARYNX.

Though an accurate diagnosis of nasal or naso-pharyngeal disease can be made only by inspection or occasionally by palpation, yet there are certain symptoms so strongly indicative as immediately to suggest examination of these organs.

Mouth-breathing usually results from obstruction in the nose or back of it. The obstruction may be from various causes, such as hypertrophic catarrh, a thickened or deviated septum, the presence of polypi in the nose, or of adenoid vegetations back of it. Though breathing through the mouth may become a matter of habit, it usually begins as a necessity induced by nasal obstruction.

The facial expression of the habitual mouth-breather is well known. There is a listless, often a stupid, look, and when with this we find combined a thickening of the bridge of the nose and a dead voice, we have strong presumptive evidence of adenoid vegetations in the naso-pharynx.

The voice in such cases is muffled and non-resonant; m and n become b and d.

There is seldom much *pain* in nasal disease, though a feeling of discomfort and pressure is common, and is often caused by an enlargement over the anterior end of the middle turbinated.

Discharge, both anteriorly and posteriorly, is frequently one of the complaints of the patient. A purulent or muco-purulent discharge from one nostril only is suggestive either of a foreign body or of disease of one of the accessory cavities. Spencer Watson classifies nasal discharges into "(1) liquid: (a) clear fluid which may be from irritation of the trifacial, or, in cases of injury, from the cerebro-spinal fluid escaping through a fracture in the cribriform plate of the ethmoid; (b) turbid or mucoid fluid of simple catarrh, which may become muco-purulent or purulent,—the latter generally from specific infection; (c) blood. (2) Semi-solid secretion indicates chronic catarrh. (3) Solid: either (a) dry crusts from chronic rhinitis, often yellow and fetid; (b) diphtheritic,—occasionally the diphtheritic membrane is expelled, but usually before this there is a sanious, irritating discharge from the nose, which, together with nasal obstruction and enlargement of glands at the angle of the jaw and along the posterior border of the sterno-mastoid, points to nasal diphtheria; (c) rhinoliths or chalky concretions accompanied by fetid, sanious, or putrid discharge."

Epistaxis.—Though, as declared by Watson, “bleeding from the nose is sometimes a remedy, sometimes a warning, and sometimes in itself a disease,” yet in the greater number of cases, certainly when frequent or prolonged, it will be found a symptom of intra-nasal disorder. There is often an abrasion on the anterior part of the septum, sometimes the sharp border of a septal ridge or spur, and sometimes serious disease of the bones of the nose, generally syphilitic. Frequent and excessive hemorrhages are occasionally a symptom of fibroma or fibro-sarcoma of the naso-pharynx.

Fetor is one of the most distressing, but, fortunately, not one of the commoner, symptoms of nasal disease. It is most frequent in the purulent rhinitis of children and in atrophic rhinitis which I believe, with Bosworth, to be the result of many of these cases of purulent catarrh. It is produced also by diseased bone, whether from syphilis or not.

Frequent attacks of sneezing are common in chronic rhinitis as well as in the acute variety, even when there is no distinct evidence of the more remote reflexes, such as asthma or well-defined hay-fever.

Ocular symptoms are sometimes produced by nasal disorder. I have seen obstinate cases of ciliary injection and lachrymation disappear immediately on removing a septal spur which was pressing against a turbinated body. Photophobia and asthenopia are occasionally caused by hypertrophic rhinitis. More grave diseases, such as glaucoma and organic affections of the optic nerve, have also been attributed to nasal influence.

Headache just between the eyes and at the bridge of the nose may be the result of rhinitis. Occipital headache may be produced by naso-pharyngitis.

Asthma is one of the most common of reflex nasal disturbances, and in every case of this disease the nose should be examined.

Cough is sometimes the result of nasal irritation; according to J. N. Mackenzie, the origin of this reflex is the posterior end of the inferior turbinated body.

Nightmare in children is occasionally caused by post-nasal obstruction.

The intimate relation between diseases of the ear and those of the nose and naso-pharynx is so fully elaborated in another department of this volume that it need merely be mentioned in this connection.

EXAMINATION OF THE LARYNX.

For examination of the larynx, the position of patient and observer should be that above described for posterior rhinoscopy, but with the head somewhat thrown back. The same means of illumination will also be sufficient here. No other instruments are needed, except that the laryngoscopic mirror should be larger than that for posterior rhinoscopy, and at an angle of about one hundred and thirty degrees. To obtain a view of the larynx, the tongue must either be held forward or depressed; the latter method is usually less advantageous, but is to be preferred in tongue-tied persons.

Generally it is best for the surgeon to hold the tongue between the thumb

PLATE I.



FIG. 1.



FIG. 2.

and forefinger of his left hand, grasping it in a towel or napkin. Care should be taken not to press it too hard on the teeth, and not to forcibly pull it forward; the former mistake causes pain, and the latter will make the posterior part of the tongue rise up and defeat just what we wish to accomplish. With the tongue held out, the light should be focussed on the uvula, and the mirror, warmed and tried on the hand, should be introduced with its reflecting surface downward and carried against the uvula, pushing it upward and backward without touching the tongue, and resting gently, if at all, on the pharynx.

In the upper part of the mirror we see the anterior part of the object reflected; in the lower part we see the posterior portion. The image reflected in the mirror is that the observer would obtain if he could stand behind the larynx and look downward and forward upon it. Thus, the right side of the larynx appears to the right in the mirror and the left to the left, only the antero-posterior relations are apparently altered.

The inclination of the mirror will depend on the relative position of patient and observer, on the contour of the throat examined, and on the angle of the mirror and stem. The usual tendency of the beginner is to tilt it too much forward; it should be turned until we see reflected in it the base of the tongue, the epiglottis, and, in most cases, the anterior portion of the larynx. On the base of the tongue are seen a group of glands constituting the so-called lingual tonsil, and sometimes so much enlarged as to press on the epiglottis and give rise to various morbid symptoms. Occasionally there is also seen here a varicose condition of the veins called by Lennox Browne lingual hemorrhoids, and believed by him to be responsible for various symptoms which are generally considered to be purely subjective. The epiglottis appears as a leaf-like curtain rising from the base of the tongue and more or less overhanging the larynx (see Plate I., Fig. 2). Its shape differs widely in different cases; usually it is symmetrical in curvature and but slightly concave from side to side on its posterior face, with corresponding convexity on its anterior; it may be sharply curved laterally or pointed at the end as in children, or longer on one side than on the other; it overhangs the larynx to a very varying degree, and chiefly determines the extent of the laryngoscopic view.

From its anterior surface three ligaments unite it to the tongue, one on each side and one in the middle; they are called the glosso-epiglottic, and between the central and lateral one is a depression, important as being frequently the seat of ulceration and occasionally of foreign bodies.

The upper surface of the epiglottis is dull pinkish in color; its border is often rolled up into a kind of lip, while below the yellow posterior surface is seen a bright-red cushion. Turning the mirror a little, we see on each side of the larynx a well-marked depression known as the hyoid fossa or sinus pyriformis. It is best seen in phonation, and with the head turned to the opposite side. In quiet respiration our view into the larynx will be more or less impeded by the overhanging epiglottis. When need be, this

difficulty may be partly overcome by having the patient say "eh" or laugh. Thus the epiglottis is raised. Beginning on each side of the epiglottis and arching downward and backward are seen two folds of mucous membrane known as the ary-epiglottic folds; in color they resemble the inside of the cheeks; they mark the upper lateral boundaries of the larynx. Near the middle line, posteriorly, each fold contains a cartilage known as the cartilage of Santorini, and just to the outside of this another eminence called the cartilage of Wrisberg; the former lie just above the arytenoid cartilages on each side. Between the arytenoids, posteriorly, is the inter-arytenoid membrane, best seen on deep inspiration, when the vocal cords are widely separated, and thrown into folds when they are approximated in phonation. Within the larynx we see, as the most striking object, the vocal cords. In quiet respiration they are separated by a triangular space whose base is posterior and apex in front; they are pearly white in color, except their posterior cartilaginous portion, which even in health is often pinkish red. On deep inspiration the vocal cords are pulled far apart, and on the production of sound they are approximated. The space between them is called the *rima glottidis*,—the chink of the glottis,—and, of course, varies in shape according to the position of the cords. Above the cords, and running from the arytenoid to the thyroid cartilage on each side, is seen a fold formed by a duplicature of the mucous membrane lining the larynx, and known as the *ventricular band*. The sac-like cavity between this and the vocal cords of each side is called the *ventricle of the larynx*.

To study the mobility of the cords, we should have the patient breathe, first, easily and naturally, then take a deep inspiration, and finally produce various sounds. As already stated, on phonation the cords approximate in the median line, while on deep inspiration they widely diverge posteriorly, thus increasing the base of the triangle which forms the *rima glottidis*.

Beneath the cords we see the subglottic portion of the larynx and the rings of the trachea, occasionally even as far as the bifurcation in the bronchi. The observer may obtain a view of the posterior wall of the larynx and a deeper insight into the trachea by holding the mirror more nearly horizontal and being himself considerably lower than the patient, if need be, by kneeling in front of him.

Though in the vast majority of cases the pursuance of these rules will be rewarded by a satisfactory laryngoscopic view, there are a few which offer special difficulties and require some addition or alteration in the method of examination. An over-sensitive pharynx is occasionally met with, but more frequently the apparent hyperæsthesia is due to clumsiness on the part of the examiner. Should the throat, however, resist even the most careful introduction of the mirror, the application of cocaine, either in a spray or, as I prefer, on a mop, will remove this difficulty; a four-per-cent. solution is generally sufficient.

Enlarged tonsils now and then impede laryngoscopic examination. An oblong or oval, instead of a circular, mirror is sometimes useful in such

cases; but tonsils so large as to be in the way should generally be removed, and further examination may be postponed till this is done. When the epiglottis is so pendent as to conceal the larynx, and is not sufficiently elevated by saying "eh" or by laughing, it should be raised with a bent probe; a spray of cocaine should first be applied, and then the hook introduced with the right hand while the mirror is held in the left.

GENERAL SYMPTOMS AND DIAGNOSIS OF DISEASE OF THE LARYNX.

In establishing a diagnosis of disease of the larynx we should carefully observe any change in its color, outline, or mobility; the exact location of any swelling, the character and symmetrical arrangement of any ulceration, and the attachment, appearance, and movability of new growths. The aid of the microscope will often be invoked in cases of suspected tuberculosis or of tumors, and occasionally when there is a membranous formation. Change of color may be confined to a small part, as, for instance, to one vocal cord, or it may be general. There is often a pallor of the mucous membrane preceding tubercular deposit, but more frequently the change of color consists of increased redness of varying degree. The ary-epiglottic folds should be carefully examined, especially the portion above the arytenoid cartilages, for any thickening, and the inter-arytenoid membrane searched for nodules or ulceration.

In chronic inflammation tenacious mucus is often seen adhering to the vocal cords, and sometimes unites them like little bridges. The surfaces and edges of the epiglottis, the sinus pyriformis, and the laryngeal walls should be minutely examined for ulcers. If any are found, their location, number, depth, outline, and symmetry should be noted. When there is marked deformity within the larynx, it is usually a consequence of syphilis, acquired or inherited. A remarkable degree of stenosis is sometimes found with but little impeded respiration. The movements of the vocal cords should be observed both in quiet and in deep respiration and in phonation.

The laryngeal probe is of service in examining new growths as well as in training the larynx to toleration of instruments. Before its use cocaine should generally be applied, either with a spray or with a mop.

The symptoms of laryngeal disease are found chiefly in alteration of the voice, in difficult or painful deglutition, in cough and expectoration, in pain and dyspnoea. The voice may be affected in any degree, from a slight huskiness to absolute aphonia. There may be inability to use the voice for singing or prolonged speaking, even when it is unchanged for ordinary conversation; the degree of its impairment is not always proportionate to disease in the larynx. On the one hand, aphonia is quite often seen with no laryngeal disorder, purely functional in character; and on the other, tumors of the larynx may affect the voice little or not at all.

Painful deglutition is generally a symptom of ulceration of the epiglottis or ary-epiglottic folds.

Laryngeal cough is usually unattended with much expectoration; it is

sometimes induced by lying down, sometimes by the use of the voice ; it is sometimes paroxysmal and sometimes almost incessant. Cough of this latter kind was a common symptom in the recent epidemic of influenza. The expectoration of blood from the larynx is not common, but it sometimes occurs in malignant disease.

Pain is also most frequently a symptom of malignant ulceration, though occasionally existing to a less degree in other forms of disease. It often shoots up to the ear of the same side, and is sharp and lancinating in character.

Dyspnœa is a symptom sometimes of laryngeal obstruction. It is usually most marked in inspiration, and it may be constant or paroxysmal.

LOCAL THERAPEUTICS IN DISEASES OF THE NARES, NASO-PHARYNX, AND LARYNX.

BY CLINTON WAGNER, M.D.,

Senior Surgeon Metropolitan Throat Hospital, New York; Fellow of the American Laryngological Association; formerly Professor of Diseases of the Nose and Throat in the New York Post-Graduate Medical School and Hospital and in the University of Vermont, etc.

THE agents employed in the treatment of the diseases of the nose and throat have increased in number within the last twenty-five years quite as rapidly as our knowledge of the pathological conditions has developed. Until the present methods of examining were discovered, the means for treatment at our command were limited, crude, and, I need hardly add, unsatisfactory and generally unsuccessful in results.

Now that the methods of using the instruments employed in making examinations for the diagnosis of diseased conditions of the throat and nose are so universally taught in our medical schools, the means for local treatment, although numerous and perhaps apparently complex, are so simplified that the physician in general practice, even if lacking the manipulative skill and experience of the specialist, is enabled to treat successfully the majority of cases occurring in the course of ordinary practice.

In the treatment of the diseases of the nose, naso-pharynx, and larynx, similar mechanical means are employed, the therapeutical agent being modified or adapted to the needs of the particular organ.

For convenience of description, the following arrangement or classification of the methods of applying remedial agents may be adopted:

- | | |
|-------------------|------------------------------|
| 1. Sprays. | 6. Galvano-cautery. |
| 2. Douches. | 7. Galvanism. |
| 3. Syringes. | 8. Nasal bougies and sounds. |
| 4. Insufflations. | 9. Tamponing. |
| 5. Caustics. | |

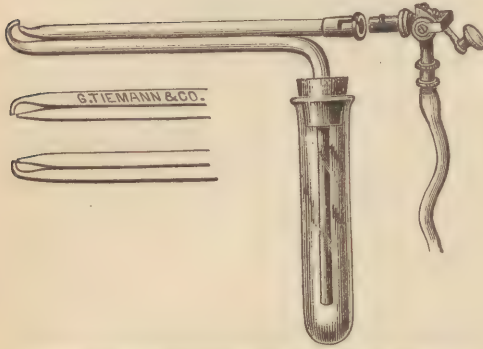
SPRAYS (NEBULÆ).

By sprays are meant solutions, either aqueous or oleaginous, medicated or not, administered in a nebulized or atomized form by means of compressed air, and forced through an instrument designed for the purpose, called a spray-tube.

The instrument used is constructed of glass or hard rubber, although metal is sometimes employed, and consists of two tubes fastened tightly

FIG. 2.

FIG. 1.



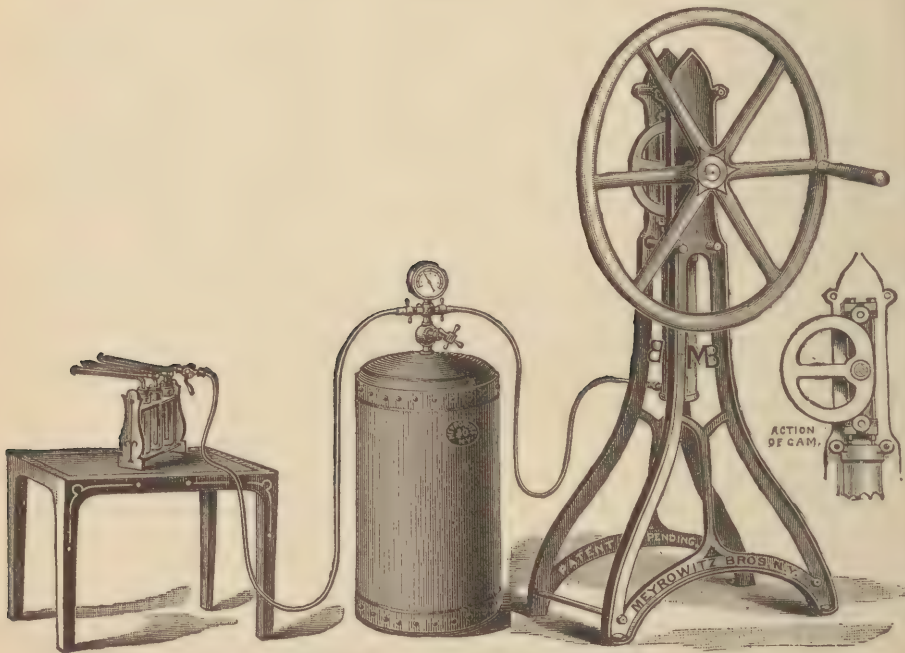
An upward, a downward, and a straight spray-tube.



A spray-tube with the spray escaping in an upward direction.

together. The turn of the end or extremity through which the spray escapes will give the proper direction; that is, if the tube is straight it should

FIG. 3.



A pump, receiver, and complete set of spray-tubes.

be used for the nose, if turned upward, for the naso-pharynx, and if downward, for the larynx. (Figs. 1 and 2.)

FIG. 4.



EXAMINING ROOM AT THE METROPOLITAN THROAT HOSPITAL.—The administration of spray. The head of the patient is thrown slightly backward, in order that the spray may thoroughly cleanse the naso-pharyngeal space. The glass between the patient and operator acts as a shield, protecting the face of the surgeon from the secretion which may be forcibly expelled from the throat and nose of the patient; especially useful in cases of syphilis, diphtheria, etc.

The liquid is atomized by compressed air, held in receivers of various designs, and the pressure or force of the spray depends upon the quantity and degree of compression of the air in the receiver, into which it is forced by means of pumps propelled by hand-power, water, electricity, or a gas-engine. (Fig. 3.) If the pressure is too great, injury may be inflicted upon the mucous membrane against which the force of the column of spray impinges, by tearing or eroding it. Care should be taken to avoid this; a gauge or measure upon the receiver will indicate the degree of pressure; from twenty to twenty-five pounds to the square inch will be found to answer in most cases, although occasionally a pressure of from thirty to thirty-five pounds will be useful in cases of ozæna, to dislodge the crusts of dry, hardened mucus when closely adherent to the turbinated bones or impacted in the passages,—of such frequent occurrence in that affection.

Nares.—To apply the spray properly and effectually to the nares, the patient should be directed to sit erect, with the head slightly inclined forward; the point of the tube is then introduced into the nostril (Fig. 4) about one-third of an inch, and the spray directed to the middle and inferior passages. With the head in the position described, the spray, upon reaching the posterior nares, will pass around the posterior border of the vomer, then downward and forward, making its exit through the nostril and carrying the accumulated secretion of mucus before it.

If the head is then inclined backward, the spray will find its way into the pharynx, cleansing the posterior surface of the soft palate, the vault of the pharynx, and the Eustachian orifices, and finally into the mouth, through which it will be expelled. In this way the entire nares and nasopharynx may be thoroughly cleansed in a few minutes.

The patient should be called upon to assist in the operation by freely and vigorously blowing the nose after each application of the spray. For the vault of the pharynx the upward spray may be used. The tongue should be depressed upon the floor of the mouth by means of the spatula, which should be held by the patient; with the palate-hook in his left hand, the operator draws the soft palate downward and forward, the point of the tube is placed behind the palate, and the spray is allowed to ascend. Except in patients who have undergone training,—that is, have had several sittings,—this method always produces more or less retching and gagging; moreover, as the cleansing may be almost, if not quite, as thoroughly performed by means of the straight tube introduced into the anterior nares as described above, the upward spray tube is not to be commended.

Pharynx.—To apply the spray to the pharynx, the tongue should be well depressed upon the floor of the mouth by means of the spatula held in the left hand of the operator or the right hand of the patient; the straight spray-tube should be held in the right hand of the operator and the spray directed thoroughly to the posterior wall of the pharynx, the tonsils, the spaces between the columns or pillars of the soft palate, and the uvula.

Larynx.—To apply the spray to the larynx, the tongue should be drawn out and held by the patient as in the examination with the laryngoscope; the point of the tube is then carried backward beyond the base of the tongue and the epiglottis and directed slightly downward and forward; at the same time the operator elevates his hand slightly, and the spray will enter the larynx without difficulty. If it is desirable to have the spray pass through the glottis, the patient should be directed, just before the spray is allowed to escape, to take a deep inspiration; during this act the cords are widely separated; at that moment the spray should be allowed to escape, and it will then pass through the glottis and into the trachea, and in some cases, if the pressure of air is sufficient, will penetrate to the bifurcation of the bronchi.

Nothing is gained by the operator holding the laryngoscopic mirror in his left hand for the purpose of giving the proper direction to the spray, for as soon as the spray escapes the mirror becomes dimmed by the deposit of moisture, thus preventing the formation of the laryngeal image. The operator's knowledge of the anatomy of the parts should enable him without difficulty to direct the spray into the larynx.

Medicated Sprays.—Medicated sprays may be divided into two general classes, aqueous and oleaginous, which may be subdivided into antiseptic, alkaline or cleansing, sedative, and astringent.

During the past few years the various products of petroleum have been introduced, and with many surgeons they have almost entirely superseded the well-known and excellent aqueous solutions so long in use. It is claimed for the oleaginous preparations, albolene, benzoinol, vaseline, cosmoline, glymöl, etc., that they are palatable, non-irritating, and capable of holding the remedies in solution required for any special effect. Admitting this to be the case, they are still wanting in one of the most important essentials of a spray, especially for the nares and naso-pharyngeal region, and that is, cleansing properties; they do not soften and detach the tenacious mucus of chronic rhinitis and the hardened crusts of ozæna,—a most important feature in the treatment of such cases. At my clinic at the Metropolitan Throat Hospital, as well as in my private practice, the aqueous solutions have invariably given more satisfactory results than the oleaginous mixtures.

Antiseptic Sprays.—Of the antiseptic sprays, solutions containing carbolic acid, iodine, permanganate of potassium, peroxide of hydrogen, and listerine, are chiefly used; of these, the peroxide of hydrogen is in many respects the most efficient.

According to J. Mount Bleyer,¹ peroxide of hydrogen is sixty times as powerful as carbolic acid as an antiseptic, and is most valuable in the treatment of tonsillitis, ozæna, diphtheria, syphilis, and all ulcerated conditions: it clearly defines the outlines of ulcers, turning them perfectly white by decomposing the pus.

¹ Medical Record, August, 1887.

Dr. Hope, in a series of observations at the Metropolitan Throat Hospital, where it has been extensively used, confirms the experiments of Bleyer.¹ In diphtheria an application should be made two or three times daily, with a coarse spray, from a pressure of about twenty pounds.

Alkaline or Cleansing Sprays.—For an alkaline or cleansing spray, my plan is to fill the test-tube with hot water (in the office or examining-room there should always be an abundant supply of running water, hot and cold), and then add a few grains—about ten—of borax, boracic acid, or bicarbonate of sodium, making a fresh solution for each patient. I also cause hot water to run over the point or end, and through the spray-tube, each time after using it, thus rendering the conveyance of disease by means of the spray-tubes impossible. The excellent mixture known as Dobell's solution is extensively employed for cleansing purposes: it consists of the following:

R Sodii bibor.,
Sodii bicarb., āā ʒi;
Acid. carbol. (cryst.), gr. xii;
Glycerini, fʒii;
Aquæ, q. s. fʒviii.
Ft. sol.

Astringent Sprays.—The mineral astringents should be used with extreme caution when applied in form of spray through the anterior nares; they are very liable to cause severe pain extending to the frontal sinus, and all the symptoms of a violent attack of acute coryza may be brought about, lasting from a few hours to several days. I have known this to occur from very weak solutions, especially of the zinc and ferric salts; for this reason they should be applied to the nasal mucous membrane only by means of the cotton-holder, thus localizing their action.

For laryngeal and pharyngeal affections they are extremely useful. The following formulæ may be employed:

R Zinci sulphatis, gr. xv, aquæ, fʒi;
Ferri sulphatis, gr. xx, aquæ, fʒi;
Ferri et ammon sulph., gr. xv, aquæ, fʒi;
Ferri perchlor., gr. xxx, aquæ, fʒi.

R Iodi, gr. iii;
Potass. iodidi, gr. vi;
Aquæ, fʒi.

Sedative Spray.—For nervous irritability of the pharynx or larynx, the following is an excellent combination:

R Sodii bromidi,
Potassii bromidi, āā gr. xv;
Aquæ laurocerasi, fʒi.
Ft. sol.

¹ New York Medical Record, October, 1888.

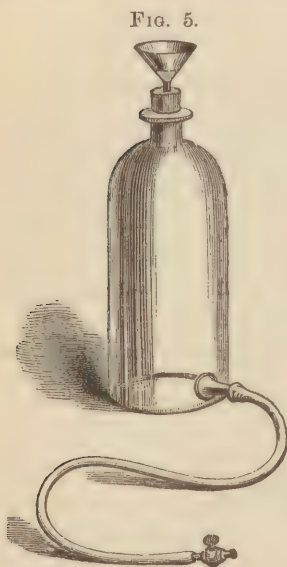
Oleaginous Sprays.—The petroleum products, albolene, benzoïnol, glymöl, cosmoline, and vaseline, require no special atomizer; the ordinary tubes will answer; in fact, they are the best adapted for the purpose. They may be used with air from the receiver or the hand-ball, and the spray should be applied in the same manner as the aqueous.

They are all more or less irritating when applied to the larynx; albolene is less so than the other preparations. It combines readily with menthol, eucalyptol, iodine, carbolic acid, thymol, terebene, etc.

THE NASAL DOUCHE.

The nasal douche, introduced some years ago by Thudichum, is a most excellent method of cleansing the nasal passages; but since the objection raised against it, chiefly by aurists, that it excites inflammation of the middle ear by allowing water to enter the Eustachian tube, it has fallen somewhat into disfavor. When this accident, which is extremely rare, occurs, it is probably due to the vessel's having been placed too high above the head. In using the douche, the head should be inclined slightly forward and down-

ward and the mouth left open; the soft palate will retract against the posterior wall of the pharynx, and the stream of water will pass around the posterior border of the vomer and escape through the nostril of the opposite side. (Fig. 5.)



The nasal douche.

Thudichum¹ recommends elevating the reservoir one to two feet above the nose: this gives great force to the stream of water, to which, if made to deviate from its course by an obstruction of any kind encountered in the nasal meatus, the Eustachian tubes would naturally furnish an outlet, and inflammation of the middle ear might be caused by the presence of the water; the elevation should not, therefore, be higher than the eyebrows, which would greatly lessen the probability of the accident's taking place.

From a pint to a quart of water, of the temperature of about ninety-five degrees Fahrenheit, containing a teaspoonful of chloride of sodium or borax, should be used once in twenty-four hours.

In suppurative conditions, five drops of tincture of iodine may be added instead of the salt or borax: it is an excellent deodorizer.

SYRINGES.

Thorough cleansing of the nasal passages can also be attained by means of syringes. For some years past I have recommended to my patients, for

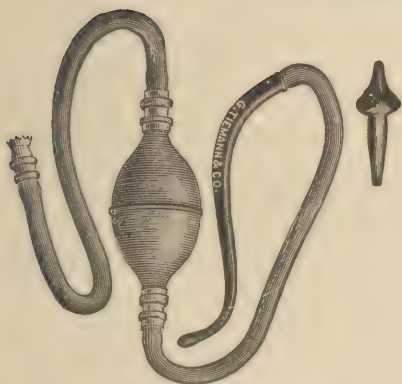
¹ Lancet, November, 1864.

use at their homes, a syringe with a nozzle closely adapted to the size of the nostril and operated by means of a rubber hand-ball. The piece attached to the hand-ball, as represented in Fig. 6, is intended for introduction behind the soft palate, the smaller for the anterior nares. An advantage this instrument has over the douche is, that the patient can regulate better the degree of force or pressure and the quantity of water thrown into the nose.

Pharyngeal Douche.—A pharyngeal douche has been devised by Dr. Samuel Johnston, of Baltimore.

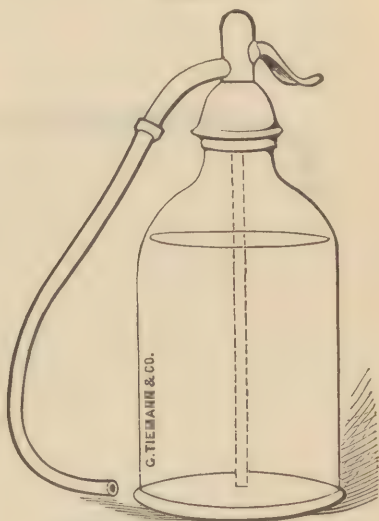
The apparatus consists of an ordinary soda-water siphon, charged in the usual way, with a soft-rubber tube twelve inches long attached to the nozzle. (Fig. 7.) The method of using it is as follows. A bit of water-proof cloth

FIG. 6.



The author's nasal hand-ball syringe.

FIG. 7.



Johnston's pharyngeal douche.

or oiled silk, large enough to protect the clothing, is first fastened around the neck of the patient, the free end of the bib resting in a basin to receive the return current. The tube is then inserted into the mouth to a convenient distance, and the pressure turned on by the attendant; the contents of the bottle will then flow with force into the mouth and out again, the force of the current varying, of course, with the amount of pressure exerted on the stop-cock.

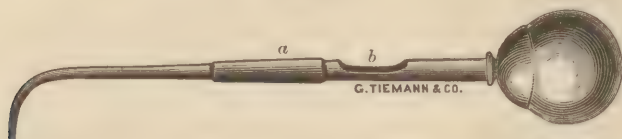
The quantity of tenacious mucus expelled by this means, in some cases, is enormous, and the relief afforded can be appreciated only by those who have had experience with this process of cleansing the oral cavity.

INSUFFLATORS.

Powders are extensively employed in the treatment of diseases of the throat and nose; they may be anodyne, astringent, or antiseptic. In pre-

paring them, they should be carefully triturated until almost impalpable; the vehicle for holding them, when one is necessary, should be of a non-

FIG. 8.



Rauchfuss's laryngeal insufflator: *a*, movable covering: *b*, cavity for the powder.

irritating character, light of weight, and not liable to absorb moisture too freely from the atmosphere. Either amylum or lycopodium will answer; the former, being odorless and tasteless, is preferable.

The instruments or insufflators used for applying the powders are

FIG. 9.



Tube laryngeal insufflator: *a*, movable covering; cavity for the powder is shown in dotted lines.

Rauchfuss's (Fig. 8); by pressing with the thumb upon the elastic ball quickly and forcibly, the powder is expelled. Another variety in use is the vulcanite rubber tube, curved for the larynx and straight for the nose; the powder is expelled by blowing through the elastic tube. (Fig. 9). This,

FIG. 10.



The author's insufflator for the posterior nares.

FIG. 11.



The author's insufflator for the anterior nares and the pharynx.

however, is an indelicate method of applying local treatment, and unpleasant alike to the patient and to the operator.

Figures 10, 11, and 12 represent insufflators devised by the author a number of years ago, which have been in constant use at the Metropolitan Throat Hospital. They may be used with the hand-ball or attached to the air-receiver for producing sprays.

Powders should be applied in the same manner as the sprays, but care should be taken not to have too much air-pressure, or they will be propelled with too much force and in excessive quantity, producing, if in the nose, much distress and pain in the frontal sinus, and if in the larynx, violent attacks of coughing, and in some instances spasm of the glottis. In making an application of powder to the larynx the laryngoscope should always be used.

Powders.—As antiseptics, iodoform, aristol, iodol, and eucrophen are employed in syphilitic and tubercular ulcerations of the nose and throat, and in ozæna, whether syphilitic or non-syphilitic. They are so bland and non-irritating in their effects that they can safely be applied pure, thorough trituration only being necessary.

Dermatol, the basic gallate of bismuth, although not antiseptic, exerts healing influences by stimulating granulations and lessening the secretion of pus.

Pyoktanin has been used by Lincoln with good results¹ in nasal and throat diphtheria, membranous rhinitis, syphilitic and non-syphilitic ozæna, suppurative ethmoiditis, etc. It is germicidal, arrests suppuration, and prevents it if impending. It may be used pure in form of powder or spray of from one to ten per cent., or on a pledget of lint saturated with a solution. Calomel one part to four parts of powdered starch, finely triturated, I have found beneficial in the ulcerations of tertiary syphilis of the nose.

Suchanneck, of Zurich, recommends the sozoidates of potash, soda, zinc, and mercury in nasal diseases. If finely powdered and combined with one or two parts of talc, they are valuable as insufflations in chronic rhinitis with profuse discharge. The following formulæ will be found useful for insufflations to the nares, naso-pharynx, pharynx, and larynx :

- Oxide of zinc, 1 part, to starch, 6 parts ;
- Subnitrate of bismuth, 1 part, to starch, 2 parts ;
- Gallic acid, 1 part, to starch, 4 parts ;
- Borax, 1 part, to starch, 8 parts ;
- Burnt alum, 1 part, to starch, 6 parts ;
- Tannic acid, 1 part, to starch, 4 parts.

FIG. 12.



The author's insufflator for the larynx.

¹ New York Medical Journal, October, 1891.

R Morph. sulphat., gr. $\frac{1}{8}$ — $\frac{1}{4}$;
Amyli, gr. v.

The following will frequently arrest an attack of acute rhinitis, if taken at the beginning as a snuff :

Phenate of cocaine, 1 part;
Antifebrin, 6 parts.
Mix thoroughly and triturate.

Pigments.—Pigments or medicated solutions are employed where it is desirable to have the application more localized than when used in form of

FIG. 13.

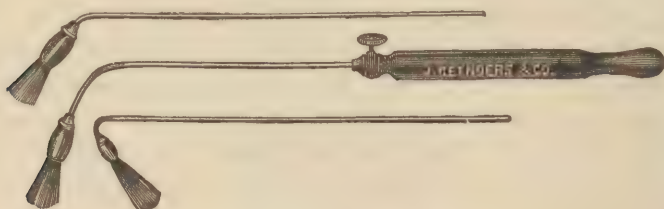


The author's nasal cotton-holder.

spray or powder ; and, besides, a stronger agent may be employed in this way than would be prudent to use by the other methods.

For making applications to the nose, a cotton-holder may be used, slightly forked at one end for the purpose of enabling it to hold firmly the cotton-wool, which is wrapped tightly around it by rotating the button at the end held in the hand (Fig. 13); another variety is somewhat longer and is roughened at the end which holds the cotton : both kinds are in use at the Metropolitan Throat Hospital. In making an application to or through the anterior nares, the patient should sit in a chair opposite the operator ; a strong light is placed immediately behind and on a level with the right ear of the patient, the head thrown slightly backward, and the nostril dilated by means of a speculum, and stretched to its fullest extent without inflicting pain upon the patient ; the rays of light are then reflected from the mirror worn upon the forehead of the operator into the nares, and the application made to the parts requiring it.

FIG. 14.



The author's post-nasal brush.

To enter the inferior meatus, the cotton-holder should be carried along the floor of the nares for about an inch, where the entrance of the meatus will be reached ; the operator should then slightly elevate his hand, and gentle force or pressure made downward and backward will carry the instrument through the meatus to the soft palate and pharynx, provided

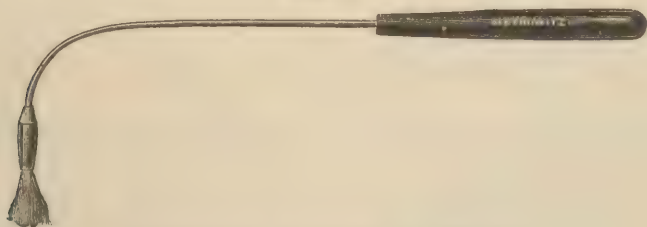
there is no serious obstruction. A perfectly straight instrument, such as the cotton-holder, can be introduced and passed through the meatus more readily than the curved instruments employed by some surgeons.

For making applications to the posterior nares, a post-nasal brush should be used. (Fig. 14.) It consists of a small, soft brush of camel's hair screwed on a rod the extremity of which is bent at an angle of forty-five degrees and the rod inserted into either a permanent or a shifting handle. In making an application, the tongue should be depressed upon the floor of the mouth by the spatula, which should be held in the left hand of the operator, as in the examination with the rhinoscope; the brush can then be introduced behind the velum without coming in contact with the posterior wall of the pharynx, by which retching, gagging, and nausea are avoided. By means of it the solution can be thoroughly applied to the posterior surfaces of the turbinated bones, the septum, and the spaces between the septum and the bones. The posterior surface of the velum can also be reached, as well as the vault of the pharynx and the orifices of the Eustachian tubes.

Larynx.—In making an application to the interior of the larynx, the patient should sit erect, as in the examination with the laryngoscope, and be directed to take hold of his tongue with the thumb and index finger of his right hand; the operator, with the laryngeal mirror in his left hand and the brush in his right, with a quick movement carries the latter downward and very slightly forward and into the larynx, generally without difficulty, although sometimes the slightest movement on the part of the patient will interfere with the entrance of the instrument into the larynx. The parts should be touched thoroughly and vigorously. The laryngoscopic mirror will enable the operator to determine whether or not the application has been properly made; if it has not, it should be repeated.

Brushes are usually made of camel's or squirrel's hair. Figs. 15 and 16 represent the brush and cotton-holder used at the Metropolitan Throat

FIG. 15.

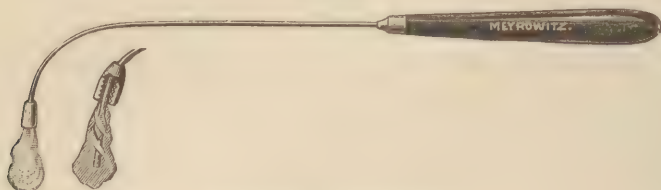


Laryngeal brush—Metropolitan Throat Hospital.

Hospital. Cotton-wool has almost entirely superseded the brush: it is more cleanly, cheaper, and can be renewed for each application. The brush and cotton-holder have both been discarded by some operators for the spray and powders. In certain conditions, especially chronic thickening of the mucous membrane covering the vocal cords, these agents pro-

duce apparently little or no effect, and a vigorous application with the brush or cotton-holder becomes necessary. Besides, the use of the brush is an excellent training for the hand and eye, and will aid one, particularly the young specialist, in acquiring the dexterity so necessary for introducing the forceps and other instruments for the removal of growths or foreign bodies.

FIG. 16.



Hope's laryngeal cotton-holder.

The following agents may be employed with the brush or cotton-holder for the larynx and pharynx. The sensitiveness of the parts to a solution of given strength of a drug varies greatly in different individuals; for instance, perchloride of iron, while ordinarily it is well borne, may in some patients excite considerable irritative reflex action; the operator must carefully exercise his judgment in the selection of remedies and the strength of the solution to be used in each case, and to avoid unpleasant consequences it is better to begin, as a rule, with very weak or mild solutions, increasing in strength as tolerance by the larynx becomes established.

- R** Zinci sulphatis, gr. xx, aquæ, f ℥i;
 Zinci chloridi, gr. xv, aquæ, f ℥i;
 Zinci iodidi, gr. xx, aquæ, f ℥i;
 Ferri sulph., gr. xxx, aquæ, f ℥i;
 Ferri perchlor., ℥i, aquæ, f ℥i;
 Ferri et ammon. sulph., gr. xx, aquæ, f ℥i;
 Cupri sulph., gr. xv, aquæ, f ℥i;
 Acid. carbol., gr. xv, aquæ, f ℥i;
 Argenti nitratis, gr. xx, aquæ, f ℥i.
- R** Iodi, gr. iii;
 Potass. iodidi, gr. vi;
 Aquæ destill., f ℥i.

The above-named solutions may also be used as applications to the nares and naso-pharynx, but reduced to about one-fourth or one-third of the strength given in the formulæ for the anterior nares. The nose is less tolerant of strong astringent and irritating remedies than the larynx.

Lactic acid has been successfully used in tubercular ulcerations of the larynx, in solutions varying from twenty-five to one hundred per cent., applied with the cotton-holder. The ulcers should first be thoroughly scraped with Heryng's curette.

Cocaine may be applied on the cotton-holder or in form of spray in solutions varying from two to ten per cent., or even as strong as twenty per

cent. in operative surgical cases. For the nares, a pledget of cotton-wool may be saturated with a ten-per-cent. solution and introduced well into the nostril and allowed to remain for several minutes just before operating. It should always be applied before making use of a caustic or painful remedy either to the throat or to the nose.

In laryngeal tuberculosis and other affections in which the taking of nourishment is accompanied with much suffering, its administration in form of spray just before taking food will afford marked relief.

Inhalations.—For administering inhalations of medicated steam, numerous inhalers have been invented from time to time; the best is that of Siegle, which is well known in this country, and is sold by all instrument-makers. In using it, the patient should be directed to sit erect, with the head slightly inclined forward, the mouth widely open and about three or four inches from the jet of medicated steam, and then inhale slowly, taking about five or six deep inspirations to the minute for five or ten minutes at one sitting; this form of inhalation is beneficial in acute pharyngeal, laryngeal, and bronchial affections. Mineral and vegetable astringent remedies may be taken by this method. In giving the essential oils by inhalation, one of the best, simplest, and cheapest inhalers is that known as Hunter's: the drug is put into the bottle (Fig. 17), which is filled with hot water, temperature about 160°: the patient can lie in bed and inhale the medicated vapor through the tubing without discomfort or effort on his part.

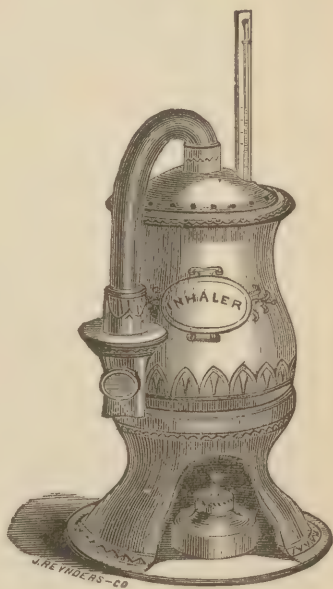
The Eclectic Inhaler (Fig. 18) is also an excellent apparatus for administering this variety of inhalation, but it is more expensive and complex than Hunter's. A pint pitcher may also be used for the purpose; a towel or

FIG. 17.



Hunter's inhaler.

FIG. 18.



The Eclectic inhaler.

thin cloth thrown loosely over the head and face while inhaling will prevent the too rapid escape of the steam.

The following are among the best of the astringent and antiseptic agents which may be administered by Siegle's or similar inhalers.

- R** Ferri perchlor., gr. ii, aquæ, f℥i;
 Ferri et ammon. sulph., gr. iii, aquæ, f℥i;
 Ferri sulphat., gr. ii, aquæ, f℥i;
 Zinci sulphat., gr. ii, aquæ, f℥i;
 Acid. carbol., gr. iv, aquæ, f℥i;
 Aluminis, gr. iii, aquæ, f℥i;
 Tinct. iodi, gtt. ii, aquæ, f℥i.

In the inhalation-room at the Metropolitan Throat Hospital a pipe connected with a large boiler generating steam extends along the wall, and has inserted into it at short intervals atomizers made of hard rubber, through which steam escapes, and from which a number of patients may inhale the medicated steam simultaneously. (Fig. 19.)

The inhalations of the volatile oils are most conveniently administered according to the formulæ of the London Throat Hospital.

The following are among the most efficient :

STIMULANTS.

- R** Creasoti (beechwood), gtt. xl;
 Magnesiæ carbonat., ℥i;
 Aquæ destill., f℥i.—M.

- R** Ol. cubebæ, gtt. l;
 Magnesiæ carbonat., gr. xxv;
 Aquæ destill., f℥i.—M.

- R** Ol. origani, gtt. v;
 Magnesiæ carbonat., gr. iii;
 Aquæ destill., f℥i.

- R** Ol. pini sylvest., gtt. xl;
 Magnesiæ carbonat., ℥i;
 Aquæ destill., f℥i.

- R** Ol. juniperi Anglici, gtt. xxx;
 Magnesiæ carbonat., gr. xv;
 Aquæ, f℥i.—M.

- R** Spt. camphoræ, f℥i;
 Spt. vini rect., f℥iii;
 Aquæ, f℥i.

SEDATIVES.

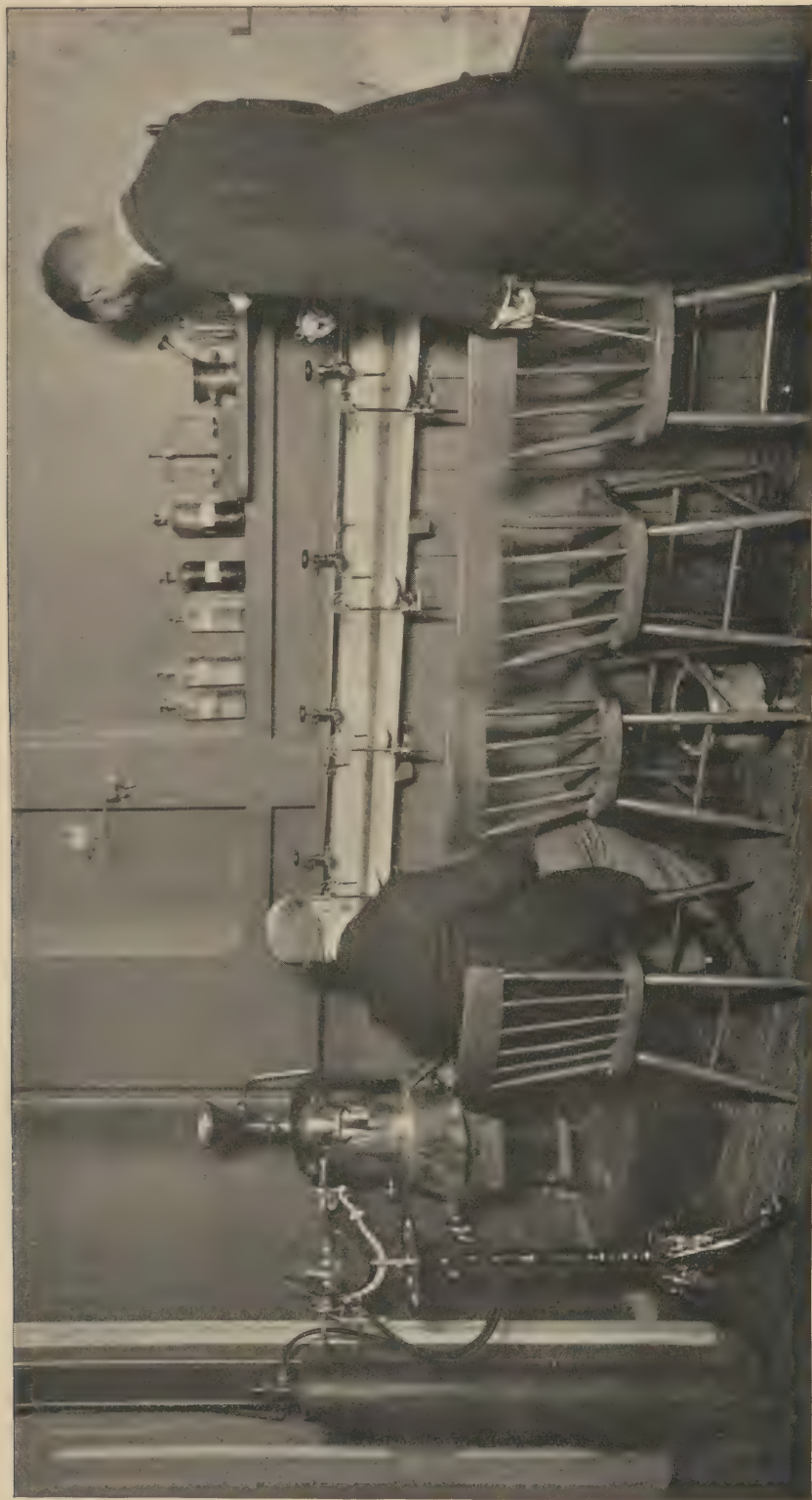
- R** Succi conii Anglici,
 Tinct. benzoini comp., āā f℥i.—M.

- R** Lupulini, ℥ss;
 Aquæ, f℥i.—M.

- R** Acidi hydrocyanici, f℥i;
 Aquæ, f℥i.—M.

A teaspoonful of any of the above formulæ to a pint of water, temperature 150° F., in the Eclectic or Hunter's inhaler, and the steam to be inhaled as already described.

FIG. 19.



INHALATION ROOM OF THE METROPOLITAN THROAT HOSPITAL.—Apparatus for administering medicated steam inhalations.

CAUSTICS.

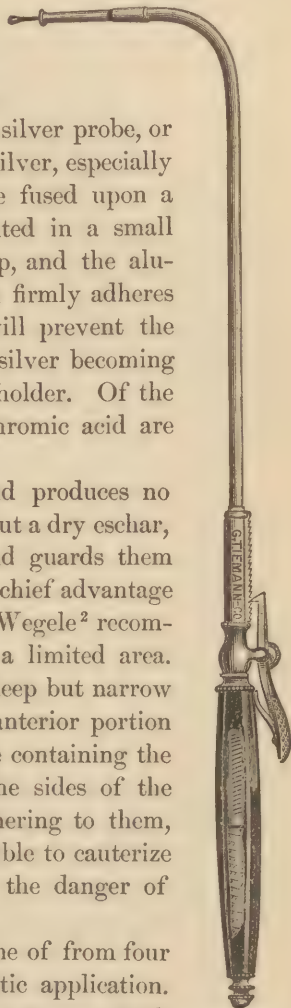
Caustic applications are frequently employed for the destruction of redundant or hypertrophic mucous membrane of the nares, and in some cases of certain varieties of intra-laryngeal growths; a tedious and unreliable plan of treatment, which should never be resorted to if removal by the forceps or destruction by the galvano-cautery is practicable.

The agents generally employed are chromic acid, chloride of zinc, trichloroacetic acid, London paste, and nitrate of silver. In making the application to the nares or pharynx, a glass rod, a silver probe, or the cotton-holder may be employed. Nitrate of silver, especially when used in the pharynx or larynx, should be fused upon a rod of aluminium: a piece of the salt is melted in a small platinum or porcelain cup over an alcohol lamp, and the aluminium rod dipped into the melted metal, which firmly adheres to it, forming a thin coating. This method will prevent the occurrence of any accident from the nitrate of silver becoming detached, as it sometimes does with an ordinary holder. Of the caustics above named, trichloroacetic acid and chromic acid are decidedly the most reliable and effectual.

According to Gleitsmann,¹ trichloroacetic acid produces no consecutive swelling, no inflammatory reaction, but a dry eschar, which remains firmly adherent to the parts and guards them against infection; in applications to the nares its chief advantage over other caustics in use is the dry eschar. Dr. Wegele² recommends the following method of applying it to a limited area. He takes an ordinary tunnelled sound having a deep but narrow gutter, and engages one or more crystals in the anterior portion of the gutter by passing the sound into the bottle containing the acid and pressing it against the side. Then the sides of the sound are carefully wiped clean of any acid adhering to them, and it is ready for use. By this means it is possible to cauterize any limited portion of the nasal cavity without the danger of touching any other part with the acid.

A thorough application of a solution of cocaine of from four to ten per cent. should always precede the caustic application. If the application of the caustic to the nares covers much surface, a pledget of lint or cotton-wool should be introduced and placed upon the cauterized part and renewed once or twice daily; otherwise, adhesions of the opposing sides may take place and give rise to stenosis or even occlusion of the meatus.

FIG. 20.



Jarvis's laryngeal caustic applicator.

¹ New York Medical Record, March, 1891.

² Ibid., December, 1891.

Cases in which this accident has occurred have come under my observation. It is not so liable to follow the application of the trichloroacetic acid, which produces a dry eschar.

In making an application to the larynx, the caustic may be fused upon an aluminium rod having the proper curve and introduced with the aid of the laryngoscope. If the operator has attained sufficient skill to introduce the brush or cotton-holder properly, he may safely undertake to make an application of caustic with the unguarded aluminium rod. There are, however, numerous ingenious porte-caustiques in which the caustic is concealed until the instrument has been introduced into the larynx and directly over the part to be touched, when it is shot forward by a spring and immediately retracts within the tube. Fauvel's, Stoerk's, Schroetter's, and Jarvis's, are among the best applicators. Fig. 20 represents Jarvis's.

Galvano-Cautery.—The galvano-cautery has many advocates, and is largely employed for the relief of the same conditions as those treated by the chemical caustic remedies.

It is less painful in its application than caustics, and more certain to produce destruction of tissue when properly applied, and should, therefore, be given the preference wherever possible. The cutting knife, points, stub, and snare, or loop, are the instruments used in applying it.

GALVANIC CURRENT.

Hartman, of Baltimore, and Delavan, of New York, report favorable results in the treatment of atrophic rhinitis with the galvanic current. The positive pole is applied to the nape of the neck, and the negative to the nasal mucous membrane, commencing with a very mild current and increasing its intensity gradually.¹ It has also been employed in anosmia. I have not, in my own practice, met with encouraging results from its use in this malady. In paralysis of the soft palate following diphtheria, one or two applications of a mild current will restore the muscles to their functions.

In aphonia resulting from functional paralysis of the adductors of the vocal cords, one application of the current frequently suffices to restore voice. The instruments employed are Mackenzie's laryngeal electrodes: one conveys the current directly to the vocal cords; the other, a necklet fastened around the neck, communicates with the other wire of the battery.

MEDICATED BOUGIES.

Medicated bougies are employed when a prolonged or continuous effect of a drug is desired. They are made of gelato-glycerin, to which is added the medicament to be used. In length they should be about three inches, cylindrical, and tapering in form.

An improvement has been recently suggested by Scanes Spicer.² A

¹ Transactions of the American Laryngological Association, Nos. 9 and 10.

² British Medical Journal, May, 1891.

hollow gelato-glycerin cylinder is inserted into the nasal passage upon hollow oval vulcanite plugs of graduated sizes for different-sized channels, variously medicated with morphine, cocaine, iodoform, aristol, mercury, etc. It is allowed to remain until the medicated cylinder has dissolved; neither cylinder nor vulcanite plug can slip back into the pharynx.

The advantage of this form of bougie is, that no filling up or clogging of the passages will take place, as may occur with ointments and powders, and that respiration through the nose will not be obstructed. They should be applied in the horizontal position and upon going to bed.

METALLIC SOUNDS OR DILATORS.

In nasal stenosis from hypertrophy of the mucous membrane, the flexible metallic sound acts beneficially by its non-yielding and resisting properties, thus favoring the absorption of redundant tissue.

The sound should be olive-pointed and slightly curved, and should be introduced and carried through the lower meatus to the soft palate, and retained in position ten minutes. The introduction should be made daily, increasing the size of the instrument as the stenosis yields. An application of an astringent solution on the cotton-holder should follow the introduction of the instrument.

MEDICATED AND NON-MEDICATED COTTON-WOOL TAMPONS.

Gottstein's tampons consist of non-medicated cotton-wool; they may be introduced into the nasal cavity on the cotton-holder used for making topical applications. Gottstein uses an instrument devised for the purpose, consisting of a screw or a shank fastened to a handle. The tampons should completely fill the entire passage. They are recommended in ozæna; their action is purely mechanical; by exciting secretion from the membrane, the crusts are kept moist and soft and the odor is thereby greatly lessened, as the dried crusts chiefly give rise to the disagreeable and pronounced odor of the disease.

Cotton-wool tampons medicated with antiseptics, astringents, or sedatives may be employed in cases where, as in medicated bougies, a continuous or prolonged effect of the drug is desirable. The following are a few of the agents used to medicate the cotton: boracic acid, iodoform, aristol, alumen, ferri perchloridum, ferri sulphas, carbolic acid, etc.

TAMPONING OR PLUGGING THE POSTERIOR NARES.

In cases of persistent epistaxis, plugging the posterior nares sometimes becomes necessary. The following method is easy of performance. Take a soft elastic bougie, insert a strong thread through the opening at the end to be introduced, carry the bougie through the inferior meatus to the pharynx below the soft palate, seize one end of the thread by means of forceps, draw it out through the mouth and attach to it the lint or cotton tampon, and then make traction upon the thread until the tampon comes in contact with the

posterior border of the septum. The thread should be allowed to protrude from the nostril.

Dr. Samuel Johnston, of Baltimore, has communicated to me a still more simple method which he has successfully tried in a number of cases.

A piece of wire about eighteen inches long is doubled upon itself and passed through one nostril, and as it appears in the pharynx is seized by the forceps and drawn out through the mouth. Into the loop a stout thread, well waxed, is inserted and the wire retracted, thereby leaving the thread in the nasal passage. Attach the plug, well oiled with carbolized oil or vaseline, and the nose is then easily plugged, anteriorly and posteriorly.

We have described the spray apparatus, insufflators, douches, inhalers, brushes, cotton-holders, etc., as well as numerous medicaments used for the local treatment of diseases of the throat and nose.

The special instruments employed in surgical operations are fully described under their appropriate heads.

They are comprised in the following list.

For the Nares and Naso-Pharynx.—Snare, cold wire, and galvano-cautery for the removal of hypertrophic tissue, polypi, and other morbid growths. Forceps of various kinds, for removing necrosed bone, adenoid growths, or foreign bodies, and for refracturing the deviated septum.

Saws, for deviation of septum and septal spurs.

Surgical engine propelled by electricity, with which are used revolving knives, cutting burrs, saws, trephines, etc., for correction of the deviated septum, removal of exostoses, etc.

For the Pharynx.—Guillotines for excision of the tonsils.

Scissors and uvulatomes for amputation of the uvula.

For the Larynx.—Cutting and crushing forceps, and guillotines, for the removal of growths; forceps for the removal of foreign bodies.

Dilators for overcoming stenosis from cicatricial tissue.

Lancets for scarifying in acute œdema.

ACUTE RHINITIS.

BY FRANCKE H. BOSWORTH, M.D.,

Professor of Throat Diseases in Bellevue Hospital Medical College, New York.

THIS term is used to designate an acute catarrhal inflammation of the mucous membrane lining the nasal cavities proper, in which not only the mucosa but the turbinated bodies take an active part, whereby the inflammatory process assumes an activity not usually met with in mucous inflammations elsewhere, because the morbid process not only gives rise to a notable turgescence of the parts, but is also attended with a very profuse serous exosmosis as well as mucous secretion.

We confine ourselves in this consideration entirely to those instances in which the inflammation is purely idiopathic, excluding those in which the turgescence of the membrane is the result of idiosyncrasy, as occurs in the various forms of hay-fever; since, as will be seen later, we regard the local morbid process in the mucous membrane in this latter disease as the result of a vaso-motor paresis purely, and as not constituting an inflammatory process.

Etiology.—An acute rhinitis may develop in rare instances as the result of traumatism, as from the inhalation of hot steam or acrid vapors, or it may mark the onset of certain of the exanthems, as measles; in the large majority of all cases, however, it is the direct result of an exposure to cold.

We are usually taught that repeated attacks of cold in the head, or acute rhinitis, result in the development of a chronic rhinitis. This I believe to be an error, since the chronic inflammation develops primarily, and the recurrent attacks of acute rhinitis become the prominent symptom of the chronic affection. An exposure to cold, in the very large majority of instances, gives rise to an attack of acute rhinitis. Why this should be is easily explained: one takes cold not by exposing the whole body to a low temperature, but by exposing only a portion of the body, as from sitting in a draught, wetting the feet, etc. The primary result of this exposure is the arrest of the nutritive processes or animal-heat-production in some one portion of the body; in consequence of this an additional stimulus is carried to some other portion of the economy, whereby heat-production and the ordinary nutritive processes in this latter region are abnormally increased. This latter, moreover, occurs in that portion of the system which is already weakened by some mild chronic inflammatory action. The nasal mucous

membrane, with the underlying turbinated bodies, is very richly endowed with blood-vessels; moreover, the important respiratory function of the turbinated bodies involves the passage through them of a large amount of blood, which varies greatly with the hygroscopic condition of the atmosphere. Hence vascular disturbances in this region are exceedingly liable to occur, more so, probably, than in any other portion of the body. Vaso-motor control, therefore, is so far weakened in this membrane that, as the result of taking cold, the inflammatory process is more liable to locate here than elsewhere. So frequent is this, indeed, that when one speaks of having taken cold, an acute coryza or cold in the head is ordinarily implied. While then we regard an exposure to cold as the exciting cause of an acute rhinitis, the predisposing cause should always be sought for in some previously-existing chronic inflammation involving the nasal mucous membrane.

Pathology.—The morbid process in this region, as before noted, differs notably from inflammatory action in other mucous membranes in the fact that the turbinated tissues are involved.

The first stage of the inflammation is characterized by dilatation of the blood-vessels, which assume an elongated and tortuous course, together with a retardation of the vascular current; at the same time the white blood-corpuscles approach the walls of the blood-vessels and finally adhere to them.

The second stage of the process is characterized by the rupture of the blood-vessels, and the escape of white corpuscles, together with the serum of the blood, which permeates the tissues and escapes from the surface. The presence of the white corpuscles in the tissues seems to stimulate all the normal nutritive processes there, and thus gives rise to the third stage, which is characterized by excessive cell-development in the mucosa proper, together with an unusual activity in all its normal processes, both of growth and secretion.

We thus find that the first stage is characterized by turgescence, with abnormal dryness of the membrane; the second stage is characterized also by turgescence, with profuse watery secretion; while in the third stage the serous exudation becomes surcharged with mucus and a large number of proliferated cells, converting it into a semi-opaque muco-purulent discharge.

Symptomatology.—The onset of the attack is marked by a feeling of general malaise, with perhaps slightly chilly sensations, and in rare instances by a somewhat well-marked chill. This is followed by a mild febrile disturbance, with perhaps pains in the bones and loss of appetite. The local changes in the membrane set in almost immediately, giving rise to a nasal stenosis, with a peculiar feeling of fulness or distention about the bridge of the nose, with smarting and tingling sensations, especially marked on nasal inspiration. There may be in extreme cases notable frontal headache, with suffusion of the eyes and intolerance of light. Sneezing becomes a prominent symptom at the beginning of the attack, but is more marked after the dry stage terminates, as it does at the end of from six to twelve hours,—namely, in the second stage of the process, which is characterized by profuse watery discharges from the nose. These at first are

clear white serum, and give a certain amount of relief to the turgescient membrane, in that the stenosis is mitigated to a slight extent. The serous discharge may continue for from twelve to twenty-four hours, and is a clear, transparent fluid of somewhat acrid character, as shown by the fact that as it emerges upon the muco-cutaneous junction it is liable to give rise to excoriations, or even an acute eczema, extending down upon the lip. On the second day usually the secretions become so far surcharged with young cells and mucus as to constitute a grayish-yellow opaque muco-purulent discharge. This may last from three to five days, when the inflammatory process gradually subsides, the whole attack usually persisting for from five to eight days.

Inflammatory processes involving the nasal mucous membrane belong essentially to late youth and early adult life: perhaps the period of life from fifteen to forty will include most individuals who are specially liable to attacks of acute rhinitis. This is a matter of clinical observation, which has been abundantly verified in my own experience. During the first ten years of life the lymphatic tissues forming the faucial and pharyngeal tonsils are especially involved in the inflammatory processes which result from taking cold, while after forty I am disposed to think that the naso-pharynx, the larynx, and the bronchial tubes become the seat of special weakness.

Another clinical fact I think is specially noticeable, and that is that in the early years of life a cold in the head confines itself entirely to the nasal mucous membrane. As these attacks recur we find that as a direct result of the nasal inflammation the faucial region or the larynx becomes involved secondarily, an acute pharyngitis or catarrhal tonsillitis, or perhaps a laryngitis, setting in on the second day of the cold, giving rise to cough and vocal impairment, with perhaps a moderate amount of secretion from the larynx and trachea. After these recurrent attacks of cold in the head have persisted for a certain number of years the patient becomes liable to so-called bronchial attacks, in which the first effect of taking cold is to develop hoarseness and loss of voice, with cough, and subsequently, after the so-called bronchial attack has persisted for one or two days, a cold in the head sets in. This latter, however, assumes the form of an acute nasopharyngitis rather than an acute rhinitis, for, whereas there is not a great amount of nasal stenosis or serous discharge from the nose, there is a profuse muco-purulent discharge anteriorly, with a certain amount of nasal stenosis, and perhaps sneezing, the source of the secretion being in the naso-pharynx, and not in the nasal cavity proper; thus verifying the assertion already made that the period of life during which inflammatory processes involve the nasal mucous membrane is generally between the ages of fifteen and forty, and that after this time this region becomes to a certain extent exempt both from acute and from chronic inflammation.

In certain cases an acute rhinitis may involve some of the accessory cavities of the nose, such as the frontal sinus or the antrum of Highmore. This is evidenced in the former case by the unusual severity of the frontal

headache, with a feeling of fulness and distention in the parts, and in the latter case by neuralgic pain, or perhaps toothache.

We possess no definite method of determining these complications in acute processes, although they are usually recognized if a chronic disease results in these cavities. Still further complications may occur with reference to the Eustachian tube or middle ear, giving rise to either temporary deafness or an attack of acute suppurative otitis media. This complication, however, occurs, as a rule, only where the chronic rhinitis which has been the cause of the acute exacerbation has existed for some time and has resulted in a mild chronic otitis media.

Diagnosis.—The recognition of a cold in the head, of course, is an exceedingly simple matter, either from subjective symptoms or on rhinoscopic examination. There are two diseases, however, with which it may be confounded, and wherein the question of differential diagnosis becomes one of no little importance: these are hay-fever and acute ethmoiditis. Under the generic term hay-fever we include all those affections, whether periodical or perennial, which give rise to vaso-motor paresis of the blood-vessels supplying the nasal mucous membrane. If we examine the nasal cavity by anterior rhinoscopy in an attack of acute rhinitis, we find the lumen of the nose largely obliterated by a swollen and turgescient mucous membrane, which presents the characteristic bright pinkish-red hue of active acute inflammation. In vaso-motor disturbances, on the contrary, while we find the membrane notably swollen and pouring out large quantities of serum or sero-mucus, it presents no evidences of inflammatory action; on the contrary, it is of a pale bluish-gray tinge, with no evidence whatever of superficial vascularity. A vaso-motor paresis, which is the essential lesion in hay-fever, involves the turbinated bodies alone, as a rule, and not the mucous membrane proper: hence the superficial blood-vessels are not distended and the membrane not discolored.

On close inspection, therefore, there is nothing in the appearance of the mucous membrane in acute rhinitis which should render it difficult for us clearly to distinguish it from an attack of hay-fever.

An attack of acute ethmoiditis gives rise to symptoms which are almost identical with those of a cold in the head. The importance of recognizing this condition at the onset of the attack cannot be overestimated, in that the acute ethmoidal attack is liable to develop a chronic purulent inflammation of the ethmoid cells, which is an essentially chronic disease, running a course oftentimes of months, and even years, before it is brought under control, and this latter effected only by surgical measures for thoroughly opening the cavity. In acute ethmoiditis the frontal headache is unusually severe, together with weakness of the eyes and perhaps a disturbance of vision. The sneezing also is of an excessive and persistent character. It is recognized by anterior rhinoscopic examination, the hyperæmia of the mucous membrane being reduced by the free use of cocaine, and a free exploration of the whole cavity well up into the superior meatus thus per-

mitted. The secretions being carefully wiped away by means of a pledget of cotton wound on a slender probe, the source of the muco-purulent discharge in ethmoiditis can be traced to the superior meatus, the bright yellow secretion pouring over the middle turbinated body from the neighborhood of the orifice of the anterior ethmoid cells. When these cells are dilated by a diseased process, they extend somewhat into the middle turbinated bone, giving rise to a certain amount of enlargement: hence we may find the middle turbinated body lying practically in contact with the septum. In such a case we can only trace, in acute ethmoiditis, the source of the muco-purulent discharge to the fissure between the middle turbinated body and the septum. If after carefully wiping it away and allowing the patient to rest for from ten to fifteen minutes we again make an examination, a renewed flow of the secretion will be observed, and the source of the discharge and the seat of the disease thus found to be in the ethmoid cells. In this point of view, therefore, it becomes a matter of some importance to make a thorough rhinoscopic examination, to determine whether we may not have to do with some serious complicating affection of the ethmoid cells, especially if the coryza has persisted for more than the ordinary period of a week, or has given rise to symptoms of unusual distress to the patient. In a number of cases of supposed acute rhinitis which I have seen, and which have been unusually persistent, I have discovered the source of the unusual symptoms in an acute ethmoiditis, and in several instances have been compelled to open these cells by snaring off the cap of the middle turbinated, in order to insure the complete resolution of the attack.

Prognosis.—The disease runs its course, as we have seen, in from five to eight days, and involves no dangerous symptoms, unless attended by some of the complications already referred to. I do not think, however, that on this score it is wise to allow a cold in the head to run its course without treatment, since, undoubtedly, each attack aggravates the chronic inflammation which we consider as underlying all these cases. Furthermore, I believe that an acute inflammation of the upper air-tract, even more than a chronic inflammation, always tends to develop weakness of the mucous membrane of the fauces, larynx, and parts below.

Prophylaxis.—There are certain measures which I regard it as the duty of a physician to enjoin upon his patient for the prevention of a cold, and which I think are not only more efficient but of greater importance than any of the therapeutic resources which we possess in the treatment of the inflammatory process after it has developed. There may be a certain amount of value in the regulation of the diet, habits of life, and exercise of the patient, but these are very general and need not be considered in this connection. Our main reliance in the way of prophylactic measures consists in the proper regulation of the clothing and the judicious use of the bath. These two measures I consider of especial importance in the management of any patient who is liable to repeated attacks of cold in the head.

Clothing.—Taking cold is associated in the minds of many with cold weather and low temperatures: hence it is a prevalent impression that we wear clothes to avoid taking cold. The object of clothing is to avoid the actual discomfort of cold weather; for this purpose we should wear a sufficient amount of covering to keep the body comfortable, and no more. An excess of clothing involves a greater risk to health, I think, than a deficiency. Certainly as far as the question of taking cold is concerned an excessive amount of clothing, instead of protecting one from taking cold, renders one peculiarly susceptible. The prevailing season of colds is in the damp and chilly days of spring and fall, rather than in the clear, crisp, cold days of winter. An excess of clothing confines bodily heat to such an extent that nature immediately endeavors to do away with this excess by the natural process of perspiration. A condition is thus induced wherein one is peculiarly susceptible to a chill. Moreover, one is far more liable to take cold when perspiring from undue imprisonment of bodily heat than where the perspiration is excited by active bodily exercise. As we have already seen, taking cold results from a disturbance of heat-production in the body. Heat is generated far in excess of the bodily requirements, and this excess is dissipated by the insensible perspiration which is constantly going on. According to physiological teaching, a pint of moisture is lost each day by this insensible process: the clothing, therefore, should be of such a character as will in the least degree interfere with this heat-radiation. The fabric which is worn closest to the skin becomes, therefore, of importance in this consideration. The fibre of silk, cotton, and linen is a comparatively straight fibre: when woven into a textile fabric the result is one which is close-meshed and not readily permeable by the cutaneous perspiration. The woollen fibre, on the other hand, is curled, and when woven into a textile fabric furnishes us one which is highly elastic, porous, and thoroughly permeable by the cutaneous exhalations.

We possess no fabric which from a sanitary point of view affords the favorable qualities of this, as worn next to the skin, in that unquestionably it hampers and interferes in the least degree with the important functions which this structure is designed by nature to perform. One of our first and most important prophylactic measures, therefore, should be to enjoin upon our patients the use of thin woollen underwear. Unfortunately, many patients complain that the skin is so sensitive that woollen becomes intolerable. It is to be regretted that our manufacturers do not recognize this more, for the commercial fabric offered in our shops invariably has the outer side smoothly dressed, while the inner side, worn next to the skin, is hairy and irritating. I have frequently obviated this objection on the part of patients by directing that their underwear shall be reversed and also laundried on the inner side.

Another serious mistake many make is in wearing too heavy underwear and changing according to the season. In our climate it is absolutely impossible to adapt our clothing to the changing temperature of the seasons.

It is an exceedingly common experience that when one changes the under-clothing in the fall or spring a severe cold is contracted. The only safety is in making no change during the year. Light woollen underwear should be worn the year round, and the outer clothing adapted for the changing temperature. When we consider that practically most of us (and certainly those whose occupation is in-doors) live both summer and winter in a temperature of about 70°, the impropriety of these changes in clothing becomes apparent. There is, undoubtedly, more safety in but a single grade of underwear and half a dozen overcoats than in four grades of underwear and a single overcoat.

Another important rule is that the clothing should be equably distributed over the body: excessive thickness in one region not only fails to protect, but rather results in mischief. A cold on the lungs is not caused by exposure of the chest, nor a cold in the head by exposure of the face. I know of nothing more mischievous than the habit of wearing a thick woollen chest-protector to protect the lungs for some supposed weakness. It not only fails to protect, but renders the individual even more susceptible. I have often said to my patients that the worst possible place to wear a chest-protector is over the chest: probably the best place to wear it would be on the soles of the feet. These latter, coming as they do in contact with cold and damp pavements, require an especial protection in thick leather soles; and here, it may be stated, a not infrequent source of mischief is in wearing rubbers and overshoes, which confine the feet and interfere with the circulation, and oftentimes render them delicate without serving any good purpose. So, also, patients especially liable to sore throat accustom themselves to thick, heavy wraps about the neck. This is undoubtedly an exceedingly mischievous practice. Sore throat is not the result of an exposure of the neck, and the throat is not strengthened by covering it. There is greater safety in the avoidance of all unnecessary covering over the face and neck than in putting them on in excess.

These are views which I have acted upon during a practice of many years, devoted exclusively to diseases of the air-tract, and I am confident that with the aid of these measures I have succeeded in many instances in arresting catarrhal troubles which otherwise would have proved exceedingly obstinate. Certainly we cannot hope to afford much relief to a patient who is constantly taking cold, and I do not believe the habit of taking cold is ever corrected by coddling or over-carefulness.

Bathing.—Of almost equal importance to the regulation of clothing I regard the judicious use of the bath as of value to us in breaking up the habit of taking cold. It is a popular fallacy that the sole object of the bath is cleanliness. Undoubtedly cleanliness promotes health, but that it is absolutely essential to health does not follow. As far as our present purpose is concerned, I regard the use of the bath as of value not for cleansing purposes, but as a stimulant to the circulation, as a tonic to the general nervous system, and as exerting an especially beneficial action on vaso-motor control,

whereby the equable and healthy distribution of blood is secured to all portions of the body.

This action of the bath is most efficiently obtained by the use of cold water. The warm bath is relaxing and depressing to a certain extent, and, as a rule, is taken by one in health simply as a matter of cleanliness; but there is nothing in the warm bath which leaves that sense of refreshment and invigoration which one experiences after the use of cold water. After all, this question of taking cold has practically to do with the regulation of heat-production in the body, and when the body at a temperature of 98° is plunged into cold water at a temperature of 50° lower, large demands are made upon the heat-production in the economy, and experience teaches us that, as a rule, it is fully equal to the demand. The daily repetition of this process cannot but have in most instances a beneficial action. From this point of view the daily use of the cold bath would almost seem to be a form of thermo-genetic gymnastics.

The best effect of cold water, I think, is obtained by the use of the plunge-bath. The direct shock to the system which is obtained by plunging into cold water seems to give us the most beneficial action of the bath. Of course, in cold weather this immersion can be tolerated for only a few seconds, and after emerging from the bath a wrap should be thrown over the shoulders to arrest radiation, when the reaction follows instantly and the drying of the skin may be accomplished at leisure. If the plunge-bath is not tolerated, the sponge may be used. Occasionally I have found it necessary to direct my patients to sponge the upper portion of the body on arising in the morning, and the limbs on retiring. No general rule can be laid down for every patient in regard to these measures. If the cold bath is well tolerated, it is immediately shown by the prompt reaction and the sense of warmth and vigor which follows immediately upon emerging from the bath. If this reaction is not obtained, of course this aid to our treatment of catarrhal cases must be abandoned; and when we speak of catarrhal cases we naturally include cases of taking cold, for in my experience a prominent symptom of most catarrhal diseases in the upper air-tract is found to be the recurrence of attacks of acute inflammation, either in the nasal cavity or in some other portion of the breathing-apparatus.

Occasionally we find that the use of the cold bath brings on attacks of neuralgia, muscular rheumatism, or other affections of this sort, in which case, of course, its use must be abandoned.

The Turkish and Russian baths are to be regarded purely as luxuries: certainly I do not believe that they possess any beneficial qualities either in the treatment of catarrhal diseases or in the prevention of colds. The patient is taken into a room at a temperature of 165° to 185° , where he remains from ten to fifteen minutes in a state of most profuse perspiration. He is afterwards taken into a scrubbing-room from 60° to 80° lower, where he remains about fifteen minutes, and subsequently takes a cold plunge or a shower. The only safety in the Turkish bath is to go from the hot room

to the cold plunge or shower until the body becomes thoroughly cooled, then the scrubbing process is endured with impunity. Going from the hot room to the scrubbing-room involves a risk of taking cold, which only a thoroughly vigorous physique escapes.

I have thus endeavored to show the value of the cold bath and the proper regulation of the clothing in the management of patients who are subject to recurrent attacks of acute rhinitis or other inflammatory affections which are the result of taking cold. These measures are aids the value of which I do not think can be over-estimated. I again repeat that the occurrence of an acute rhinitis should be accepted as evidence of the existence of a chronic inflammation underlying it, and, while we avail ourselves of the general hygienic measures above detailed in the treatment of our cases, it becomes an important duty also to relieve the chronic morbid process. In this manner we remove not only the exciting cause but also the predisposing cause of the attacks.

Treatment.—There is a fair promise in most cases, probably, of aborting an attack of acute rhinitis, if measures for this purpose are instituted sufficiently early. Certainly if seen within twenty-four hours the attempt should be made to arrest the inflammatory process by abortive treatment, which consists in the administration of ten grains of quinine together with an equal amount of Dover's powder. At the same time a hot posset should be given, and the feet immersed in hot water until a more or less profuse diaphoresis is secured. A still simpler plan of accomplishing this consists in wrapping the patient in a flannel blanket and placing him in a chair under which a spirit-lamp is lighted. This position should be maintained from ten to fifteen minutes, when, enveloped in the same wraps, he retires to his couch. The perspiration is not to be regarded as the direct object of these measures, so much as the evidence that the end has been attained of thoroughly surcharging the body with heat, thereby restoring that equilibrium which the exposure to cold has disturbed. As the result of this procedure, the inflammatory process will either be completely arrested or markedly curtailed. If on the following morning the nasal cavity is still the seat of much irritation, some of the mild measures hereinafter to be suggested in the way of inhalations or insufflations may be resorted to.

When cases present themselves for office-treatment, the following measure is one which in my own hands has been attended by the most uniformly successful results. A twenty-per-cent. solution of cocaine is first applied by means of a spray to the nasal mucous membrane. The result of this is that the turgescence is completely ablated by the expulsion of the blood, and there remains nothing more than such hypertrophy as may have developed in connection with the chronic rhinitis which, as we have seen, underlies practically all these cases of acute inflammation. This also enables us to estimate, of course, the degree of the chronic inflammation which exists. The membrane having now been thoroughly dried by means of a pledget of cotton, a small amount of chromic acid in crystal form is taken up on the end of a slender

probe, and, being held over a lighted lamp, is melted, after which it is allowed to cool. There is thus formed on the end of the probe a minute globule of the caustic in an amorphous state. This simply furnishes us with an exceedingly convenient method of manipulating the acid. The prominent portion of the exsanguinated mucous membrane covering the lower turbinated bone is now cauterized over an area which practically embraces the apex of the anterior portion of the turbinated body. The result of this is to form an inelastic and closely adherent slough in the superficial portion of the mucous membrane, which acts in such a way as to pin it down, as it were, and thus prevent the return of blood to the parts after the action of the cocaine has passed away. This plan of treatment consists practically in abolishing the acute features of the rhinitis and reducing it, by means of cocaine, to a simple chronic or hypertrophic rhinitis for the time, the permanence of this action being secured by the use of the caustic in the manner above described. This plan of treatment is, of course, entirely painless, and, moreover, does not add to the abnormal irritation which exists in the membrane as the result of the acute inflammatory process. Certainly in my own hands I have found no plan of treatment which is comparable to this in arresting the progress of an acute rhinitis by thus practically shutting off the blood-supply from the parts in the manner above outlined.

While a cold in the head practically invades both nostrils in all instances, the inflammatory process oscillates from one side to the other, and when seen is usually much more marked on the one side than on the other: hence the cauterization should be made on the side in which the greatest turgescence is noted. The same plan of treatment might be resorted to in both nares at the first sitting. As a rule, however, it is wise to postpone the second application on the opposite side until the following day. The patency which is thus secured to the one side, furthermore, reacts to a certain extent on the other, in such a manner as to leave the patient in a condition of comparative comfort.

There are certain local applications which afford notable relief, both in reducing the turgescence of the membrane and in allaying the sense of heat and irritation which the patient experiences. Prominent among these is the Ferrier¹ snuff, as follows:

R Morphinæ hydrochloratis, gr. ij;
Pulv. acaciæ, ʒij;
Bismuthi subnitratæ, ʒvj.—M.

A pinch of this is to be insufflated into each nostril as the patient desires. It is to be borne in mind, however, that morphine is quite as rapidly absorbed by the nasal mucous membrane as by the stomach, and the possibility of obtaining its toxic effects is to be considered. The following powder is recommended by Robinson:²

¹ London Lancet, 1876, vol. i. p. 525.

² Nasal Catarrh and Allied Diseases, second edition, p. 56, New York, 1885.

R Pulv. fol. belladonnæ, gr. xx;
 Pulv. morphinæ sulph., gr. ij;
 Pulv. gum. acaciæ ad ʒss.—M.

Of late years camphor has enjoyed a well-merited reputation in catarrhal colds, used both by inhalation and insufflation. The following combination answers an excellent purpose in the form of snuff:

R Camphoræ, gr. x;
 Antipyrin., gr. xij;
 Sacch. lactis ad ʒijj.

The use of menthol in a similar manner is advocated by many, as in the following formula of Rabow:¹

R Menthol. pulv., gr. ij;
 Caffææ tostæ,
 Sacch. alb., āā gr. ij.—M.

Cocaine is probably the only drug in the Pharmacopœia whose action can absolutely be depended upon in reducing vascular turgescence in mucous membranes. This property would naturally suggest its value in an acute rhinitis. Experience teaches us, however, that its beneficial effects are not to be depended upon in this affection, since the vascular contraction is maintained for only a comparatively short period, after which the turgescence returns. If applied every half-hour by means of a spray, temporary relief undoubtedly will be afforded, but used in this amount the constitutional action of the drug is so quickly obtained, in nervousness, sleeplessness, headache, and cardiac irregularity, that its use may be followed not only by discomfort but even by dangerous symptoms.

The application of astringents to an inflamed mucous membrane, such as tannin, nitrate of silver, sulphate of zinc, sulphate of copper, etc., is recommended by many observers. I doubt if their use is attended with any benefit.

Hot steam-inhalations are always grateful, and may be rendered more efficient by incorporating in the boiling water various of the volatile oils or oleoresins, as in the following:

R Tinct. lupulin., fʒj;
 Tinct. benzoini comp., fʒvij.

or:

R Menthol., gr. xx;
 Tinct. iodi etherealis, fʒij;
 Alcohol. ad fʒij.—M.

or:

R Camphoræ, ʒss;
 Ol. eucalypti, ℥x;
 Terebin., ℥xij;
 Alcohol. ad fʒij.—M.

¹ Deutsche Med. Wochenschrift, 1886, No. 5.

A teaspoonful of any of the above is to be added to a half-pint of boiling water, in an open-mouthed bottle, and the fumes inhaled either directly into the nose, or through the mouth and forced out through the nose.

The comfort of the patient is in no small degree promoted by the use of pocket-inhalers or vinaigrettes containing one of the following :

R Ol. menth. pip., f ʒj ;
Ammon. carbonat., ʒss.

OR :

R Menthol., ʒj ;
Camphoræ,
Ammon. carbonat., āā ʒij.—M.

A popular German remedy, known as Hager's, is the following :

R Acidi carbolici, ʒj ;
Alcohol. fort., f ʒiij ;
Aquæ ammoniæ fort., f ʒj ;
Aquæ dest., f ʒij.—M.

This is to be used as an inhalation from an open-mouthed bottle.

A domestic remedy of some repute consists in placing on the stove a cup containing equal parts of water and vinegar and allowing it to simmer, thus diffusing the vapors of the acetic acid through the room. Following out this idea, the following combination is recommended by Fritsche :¹

R Acidi acetici glacialis,
Acidi carbolici, āā gr. ij ;
Ol. pini sylvest., ℥viij ;
Tinct. moschi, f ʒij.—M.

This is also to be used by inhalation.

In addition to local medication, a patient suffering from a cold should be placed on the use of quinine in two-grain doses given three times daily, or, better still, I think, salicin given in ten-grain doses. This should be continued for at least five days, or longer if the local symptoms persist. Occasionally excellent results will be obtained by substituting for the quinine or salicin given in the above manner smaller doses of these drugs more frequently repeated, and in combination with certain remedies which seem to exercise a controlling influence upon the local inflammatory process. This change is made where the local symptoms have assumed an aggravated form. If the watery discharges are profuse and the pain and irritation about the nasal passages severe, the following may be given :

R Codeinæ,
Extract. belladonnæ, āā gr. iv ;
Salicin., ʒiss.
M.—Ft. mass. in pil. no. xxx div.
Sig.—One every three hours.

¹ Berl. klin. Wochenschrift, 1887, No. 27.

Or if the constitutional disturbance is marked, the following may be administered :

R Extract. belladonnæ, gr. iv ;

Zinci oxidi, gr. xv ;

Phenacetin., ʒ iss.—**M.**

Ft. mass. in pil. no. xx div.

Sig.—One every three hours.

A somewhat common practice among physicians is to confine patients with a cold in the head to the house, and oftentimes to bed. I doubt if this is always a wise procedure, for while confinement at home should be enjoined, of course, during inclement weather, I have not infrequently seen a walk in the fresh air during the middle of the day exercise a beneficial effect rather than otherwise on a patient, even in the height of an attack of acute rhinitis. Confinement to bed I should regard as unnecessary, unless the constitutional symptoms were of an aggravated character or some of the serious complications of the affection are threatened, such as involvement of one of the accessory sinuses or of the auditory apparatus.

INFLUENZA AND AMERICAN GRIPPE, OR EPIDEMIC MYXOIDCEDEMA.

BY CARL SEILER, M.D.,

Lecturer on Laryngology in the University of Pennsylvania; Chief of the Throat Dispensary in the University Hospital; Late Curator of the Philadelphia Pathological Society, etc., Philadelphia, Pennsylvania.

A FORM of acute inflammation of the upper air-passages which occurs epidemically at varying intervals of time in different countries is the so-called influenza, which presents the same symptoms, only in perhaps a more aggravated form, that are seen in the ordinary non-epidemic acute laryngitis, pharyngitis, and coryza.

This disease, which affects also the domestic animals, and particularly horses, has been variously named in different countries and different languages, but always by a nickname, such as "influenza," "la grippe," "blitz-catarrh," "epizooty," etc.; but never has the disease received a scientific name, in all probability because it was looked upon as a trifling affair which did not require the attention of physicians, and the latter did not trouble themselves about making careful investigations.

Dr. J. C. Wilson, of Philadelphia, in an excellent article on this disease, in the "System of Medicine" by Pepper, gives a full detailed account of the earlier history and of the various epidemics which have been observed, and we find there that in a number of these epidemics in the last century the mortality was very great, but we also find that in those epidemics the symptoms were different in many respects from those in the simple epidemics without mortality, and it is therefore probable that this heavy mortality was due to another disease, which somewhat resembles influenza, and which in this country has been called grippé. In this article I shall endeavor to draw the distinction between these two diseases in as few words as possible, and therefore shall give simply the outlines of the symptoms of influenza and of grippé separately. I may be criticised for doing so, as I have been before, yet I think I am justified in making this distinction, because a large experience has proved the correctness of this theory.

INFLUENZA.

In all the epidemics of influenza which have been carefully observed within the last twenty-five years the patients were usually seized rather suddenly with a burning sensation in the eyes and nose, followed by sneezing,

frontal and occipital headache, pain in the pharynx, difficult and often painful deglutition, and hoarseness. After a few hours the conjunctivæ became injected (whence the name sometimes given of "pink-eye"); the eyelids were puffed and swollen and there was profuse lachrymation; the nasal mucous membrane also became swollen, so as to occlude the anterior nasal chamber, and poured out a profuse watery discharge. The tonsils and pillars, the velum, and, in aggravated cases, the mucous membrane of the larynx, participate in turn in this tumefaction, so that sometimes deglutition and vocalization become not only painful in the extreme, but even impossible, and the swelling in the larynx may produce stenosis, and tracheotomy becomes necessary to save the life of the patient.

On inspection, the mucous membrane throughout the affected portions of the upper air-passages is intensely red, and presents all the features of acute inflammation. But we never see any pseudo-membranes or what appear like mucous patches on the surface of the mucous membrane.

In the majority of cases the sublingual and submaxillary glands are swollen and painful to the touch, the constitutional disturbance produced by this extensive inflammation is naturally considerable, and we have a very dry skin, a high pulse-rate, and high temperature, together with insatiable thirst, but there is no particular malaise or pronounced weakness or feeling of exhaustion. The duration of the disease, which is self-limited, is from ten days to two weeks from the onset to full recovery, and treatment, as in the case of acute coryza, does little to shorten this time. Whether there is or is not a period of incubation is uncertain, as is also the cause of the wide-spread epidemics. The recovery is in all cases complete, and the patient does not experience any inconvenience or impairment of health and vigor from the attack.

Treatment.—The treatment should be directed towards the alleviation of the suffering and the general febrile condition. Antiphlogistics, diuretics, and diaphoretics, as well as antipyretics internally, should be given, and I find a modified form of Basham's mixture, made with fresh lemon-juice instead of citric acid, excellent as a diuretic. At bedtime a five-grain Dover powder, repeated in an hour if the patient does not sleep, is also of great advantage; and in the later stages quinine in two-grain doses every three hours acts kindly. The new antipyretics derived from the distillation of coal-tar may be of advantage, but, as they have a depressing effect upon the heart, it seems to me to be a dangerous experiment to exhibit them. Sponging the body with lukewarm water or vinegar and water affords great relief from the burning and dryness of the skin, and also lowers the temperature considerably. Stimulants of any kind should not be given, as they invariably increase the tumefaction of the nasal mucous membrane and thereby increase the headache and difficulty of respiration. Locally the spray of the antiseptic alkaline solution in the nose and throat, every two or three hours according to the severity of the symptoms, applied with the atomizer, gives relief. Nitrate of silver solution should be painted over

the tonsil, as in acute tonsillitis. Cold compresses over the swollen eyelids, and the instillation of a drop of four-per-cent. solution of cocaine into the eye, afford great relief from the pain due to the acute conjunctivitis. Cocaine solution introduced into the nostrils by means of a pledget of cotton saturated with it and allowed to remain there a few moments causes a shrinking of the turbinated tissue, which effect may be prolonged by following the cocaine with a spray of a four-per-cent. solution of antipyrin. This gives great relief from the nasal stenosis, but is only temporary in its effect. Poultices to the neck have a tendency to relieve the pain of the swollen glands.

AMERICAN GRIPPE, OR EPIDEMIC MYXOIDCEDEMA.

For a number of years past, as early as the winter of 1885, I observed a peculiar class of cases, which did not, according to the symptoms, come under any of the different classes of diseases of the upper air-passages, whether local or systemic, and I was at a loss to classify or name the group of peculiar symptoms as a known disease, and still more so how to treat it, because the ordinary method, of treating symptoms when the cause is unknown, failed utterly.

In 1888 I had occasion to compare notes on this subject with my friend Dr. Glasgow, of St. Louis, who had made similar observations, and who, recognizing the malady as an undescribed and heretofore unnamed disease, had, like myself, called it "It," for want of a better name. In April, 1889, I published a very short account of the disease as it was then prevalent in an epidemic form all over the United States. In the beginning of June of the same year Dr. Glasgow read a paper on the subject at the meeting of the American Laryngological Association at Washington, and I read a more exhaustive paper than my first one on the same subject before the American Medical Association at its meeting at Newport, Rhode Island, in June, 1889. In this paper I gave the full description of the symptoms, as well as of the treatment which had proved the only successful one so far.

In December, 1889, fully six months later, the newspapers announced the invasion of New York City by an epidemic of influenza or "grippe," with an extremely high death-rate, and this epidemic rapidly spread all over the United States, respecting neither climate nor altitude, and was more fatal than even cholera or yellow fever could have been. This epidemic disease is still in the country, as it had been before, and the alarming epidemic outbreak must be attributed to a mixture of the undescribed "It" and the genuine influenza, which was then raging all over Europe and part of Asia. This mixture, as well as the hasty and uncalled-for naming of the epidemic by the newspapers, was extremely unfortunate, because the two distinct diseases were not differentiated one from the other, and all cases alike were treated by physicians, as well as by the laity, according to the well-known efficient treatment of influenza, and many lives were thereby

lost, and many are to-day lost for the same reason. As I can claim the priority in having described the disease, and because it certainly is necessary in my estimation that some distinction should be made between it and the French "la grippe" or influenza, I take the liberty of naming it, and perhaps the best popular name that suggests itself is "*The American Grippe*." For a similar reason a disease resembling measles in some features, but differing in many other respects from measles, is called "German measles." The scientific name is chosen as it expresses the pathological condition which is always present: the name is myxoid-œdema epidemica, and the pathological feature which it expresses is a mucoid infiltration into the submucous tissue.

Symptoms.—The symptoms of this disease are in the beginning alike in all cases, but very soon a variety of symptoms present themselves in different cases according to the location in the alimentary or the respiratory mucous tract of the focus of irritation. Thus I shall describe a case affecting the upper air-passages in detail, touching, however, upon the other forms incidentally, for the sake of comparison. The onset of the disease is usually very sudden, the patient being stricken in perfect health with a pain of a rheumatic or neuralgic character in the back, neck, or limbs, a feeling of utter prostration and a fear of impending evil accompanying the pain. Gradually the temperature rises, and may reach a very high point, which is maintained with little or no fluctuation. The pulse, on the other hand, remains normal, but becomes weaker as the heart fails more and more, and may rise after a few days of illness, but never goes above 100° in ordinary uncomplicated cases. The tongue shows a moist grayish-white coating which does not cover the edges and the tip; the organ is flabby and shows on its edges the impression of the teeth. The skin is moist over the whole body, and a slight exertion, either mental or physical, in many cases produces profuse perspiration. The patient does not complain of thirst, but his appetite is completely gone, as are the will-power and mental energy, so that he is in a state of mental lethargy. It will thus be seen that there is no *fever* present, because the only symptom or indication of fever is a rise of temperature as indicated by the thermometer, and the other indications, dryness of skin, increased pulse-rate, and thirst, which must be combined with the elevation of temperature to produce that state of the system termed fever, are absent (Dunglison).

Experiments on animals for the purpose of determining the location of the heat-centre in the nervous system have proved that temperature as indicated by the clinical thermometer can be raised or lowered by the irritation of one or the other of these centres without either the pulse-rate or the degree of moisture of the skin being affected thereby in the slightest. Unfortunately, the thermometer is relied upon solely by the physician to determine the presence or absence of fever: his main object when there is fever is to lower the temperature, irrespective of the condition of the arterial or nervous system, and he exhibits at once the powerful heart-

depressing patent antipyretics. If it is a case of the respiratory variety, the patient complains of sore throat, painful deglutition, difficulty of breathing, and a slight cough with scant expectoration. There is no running of the nose, no sneezing, no conjunctivitis or swelling of the eyes, but they have a dull glassy look. Difficulty of breathing is observed occasionally, and in a few cases tracheotomy may have to be resorted to to save life. On inspection the mucous membrane of the throat appears of a pale bluish-pink color, with here and there spots of a deeper red, and here and there also in many cases a pseudo-membrane adhering tightly to the surface. This membrane differs from the pseudo-membrane of croup and diphtheria in color, being of a bluish-white hue, and giving the impression to the eye of opalescence; it never curls up at the edges, nor does it ever become yellow or brownish, and if pulled off by force discloses not a true ulceration beneath, but simply a bleeding abrasion of the mucous membrane. As the case progresses toward recovery, or at least beyond the acute stage, the membrane gradually fades, becoming thinner and thinner, until finally it presents the peculiar glistening pinkish surface so well known in syphilitic affections as a mucous patch, for which in one or two instances in the author's experience it had been mistaken. This membrane also is distinguished from the diphtheritic pseudo-membrane by the absence of any odor.

The body of the mucous membrane itself appears puffy and swollen, and feels doughy to the touch of the probe, so that in many cases the anterior or posterior pillars of the palate, the uvula, the arytenoid cartilages, ventricular bands, and other portions of the mucous membrane appear oedematous, without, however, presenting the scarlet color of the ordinary oedematous swelling of acute inflammation. An incision into the swollen portion with a view of evacuating the contents fails in its object, and only a drop of straw-colored viscid gelatinous material makes its appearance, which when grasped with a forceps can be pulled out to a length of from four to six inches without breaking the thread. It will readily be seen that if this mucoid infiltration into the submucous tissue of the respiratory tract, particularly in the anterior nasal cavities and in the larynx, assumes large proportions, it must give rise to the symptoms of dyspnoea already mentioned, and that when it becomes more prominent in the mucous membrane of the bronchi and bronchioles it will produce a condition closely resembling pneumonia as diagnosed by auscultation and percussion. There are, however, a large number of cases in which this mucoid infiltration occurs only in the mucous membranes of the stomach, when it gives rise simply to gastric symptoms and is diagnosed as acute gastritis, or in the small intestine, when it is usually diagnosed as typhoid fever, or in the large intestine, when usually typhlitis and enteritis are the conditions diagnosed. In a few instances the only visible symptom or lesion was a skin-eruption, such as urticaria and eczema covering the whole body, while in other cases an eruption closely resembling measles, scarlet rash,

and even varioloid, was observed, without, however, presenting the characteristic systemic symptoms of these exanthemata, and they readily yielded in an incredibly short time to the proper treatment of American grippé.

Another manifestation of the "American grippé" is that form of the disease which might be termed nervous, in which the only subjective symptom is a disturbance of the nerve-centres, resembling in some cases cerebral meningitis, spinal meningitis, hemiplegia, etc. But in all these obscure and misleading varieties, at least in the early stages, the peculiar clinical features of American grippé—namely, the moist skin, the flabby and white coated tongue, the low pulse-rate, the high temperature, the absence of thirst, and the extreme weakness and apathy—are invariably present; and by these features the true nature of the disease may be at once recognized, and the appropriate treatment of the disease will confirm the diagnosis.

In those cases in which the attack is not a very severe one and in which the heart is not seriously affected, all the above-enumerated symptoms appear in so light a form that they are hardly noticed by the patient, and it is not until weeks afterwards that his attention is called to the attack by the appearance of the symptoms of the chronic form.

The duration of the disease is unknown, as it is not a self-limited affection and is very apt to become chronic, and one attack predisposes to subsequent attacks at frequent intervals. There is apparently also no period of incubation. The cause or causes of the malady are likewise unknown, as various and repeated experiments and cultures have failed to show any specific bacteria, and as the disease has made its appearance at all seasons and in a variety of altitudes, respecting neither the rich nor the poor, and appearing with like force in the squalid alleys and in the fashionable streets of large cities. The chronic form, like the acute form, has peculiar clinical features which are present in all cases, no matter what the peculiar specific symptom may be: these features are loss of ambition, weakness, more or less profuse perspiration on mental or physical exertion, showing itself particularly in the palms of the hands, insomnia, or fitful sleep which is not refreshing to the patient, who feels more depressed and out of sorts in the forenoon than in the afternoon and evening. The appetite is fickle, the bowels irregular, and the urine scant and of a high specific gravity, but no albumin or sugar can be found in it unless Bright's disease or diabetes had existed prior to the acute attack. The memory, particularly for names and numbers, is seriously affected, and recent events, owing to the sluggishness of the mind in appreciating them, are more readily forgotten than older remembrances; concentration of the mind for any length of time is impossible; and these mental symptoms in many cases develop into insanity, usually of a mild monomaniacal form. The patient almost always complains of ever conscious and yet uncontrollable dreams, which disturb sleep and resemble as closely as can be the visions of delirium tremens. In many cases a pain of the eyeballs is complained of, and it is described as a pushing from behind, as though a pair of thumbs

were pressing upon the eyes within the skull, and vision is greatly interfered with and sometimes totally lost. In still another variety of cases chronic skin-eruptions due to nervous irritation form a prominent symptom, such as lichen both planus and rubra, eczema, psoriasis, etc. In fact, space does not allow me to enumerate all the various predominant symptoms of chronic American gripe which have come under my notice, and the above must suffice to give an idea of the scope in which the disease manifests itself. As far as the mucous membrane of the upper air-passages is concerned, a little more detailed description of its appearance and of the disturbance of its functions may, however, be admissible. On inspection of the nasal cavities or throat in a case of this kind, we find the mucous membrane throughout the upper respiratory tract of a pale bluish-pink color, it feels to the touch of the probe "doughy," and to the eye appears more or less wrinkled and relaxed. The secretions are diminished in quantity, and collect as white glairy mucus in the laryngeal, naso-pharyngeal, and anterior nasal cavities, thus giving rise to a slight hacking cough, a feeling of fulness in the upper portion of the throat, and obstruction to nasal respiration. This latter symptom is increased in its severity by the indolent swelling of the turbinated tissue due to the mucoid infiltration into the submucous tissue, thus resembling true hypertrophy of the erectile tissue. The same condition—namely, scant and thickened secretion, together with infiltration into the submucous tissue—is very frequently found in the bronchi and bronchioles, thus closely simulating chronic phthisis both in the general condition of the patient and in the physical signs.

Treatment.—The treatment of the acute form of American gripe should not be directed towards the symptom which is most prominent,—namely, elevation of temperature,—but should aim to eliminate from the system the poison (whether it be a ptomaine or bacteria) which by its powerful effect upon the nerve-centres gives rise to the symptoms. And here more clearly, perhaps, than in any other disease nature (*vi naturæ curantur*) asserts itself and shows us the way. The profuse perspiration on exertion, the high specific gravity of the urine without albumin or sugar, and the finding invariably of a healthy kidney-structure when all other organs were found to be diseased on post-mortem examination of fatal cases of the disease, clearly indicate that the skin and the kidneys are the only channels through which the poison can be eliminated from the system. At the same time, through the extreme debility, the weakness and slowness of the pulse, nature indicates that the heart is failing and must be supported, and that the high temperature is only the result of the irritation of the heat-centres and not due to increased arterial pressure. Thus, acting upon the suggestions of nature, as well as upon a suggestion thrown out in an article in one of the German medical journals which recommended the benzoate of sodium in large doses as a specific for diphtheria, Dr. Glasgow and myself arrived at the conclusion that that formerly much vaunted but now almost forgotten drug would be the proper remedy to aid the skin and kidneys, and that the

heart was best sustained by alcohol in small but repeated doses, together with *absolute rest*. This line of treatment has given the greatest satisfaction to all who have had the courage to disregard the idea that a high temperature whenever found must be combated vigorously, and without regard to any other symptoms present, by means of the recent synthetic patent antipyretics.

The usual method pursued is to administer ten grains of benzoate of sodium in half a tumblerful of plain or, better, carbonated water, a tablespoonful of either whiskey, brandy, or other liquor every three or four hours, and *absolute rest* and quiet *in bed*. Simple as this treatment is, it produces the desired result, and the author has seen most severe cases of this acute form, with the pharynx and nasal cavities filled with pseudo-membrane and deglutition almost impossible, completely recovered in three times twenty-four hours; and in one case of eczema covering the body from head to foot he has seen the eruption disappear completely in less than a week under this treatment. In the chronic forms of the disease it has been found that the benzoate of sodium alone is not well borne by the stomach in such large doses for any length of time, and therefore the author uses the following formula :

R Sodii benzoat., $\overline{3}$ ss;
 Liq. ammon. acet., $f\overline{3}$ iss;
 Inf. buchu (fresh), q. s. ad $f\overline{3}$ viii.

Sig.—A tablespoonful in water four times daily.

This mixture, which for the sake of convenience has been named *mistura buchu composita*, loses the disagreeable, acrid, bitter-sweet taste by aging, and it is well, therefore, to put it up in large quantities.

As a tonic and heart-stimulant, whiskey or brandy, or any other liquor, alone, has its well-known disadvantages when it becomes necessary to administer it for any length of time; and the following formula may with advantage be substituted for it:

R Elix. gentianæ, $f\overline{3}$ iss;
 Tinct. cinch. comp, $f\overline{3}$ ss;
 Syr. limonis, $f\overline{3}$ i;
 Spt. frumenti, q. s. ad $f\overline{3}$ viii.

Sig.—A tablespoonful three times a day before meals.

At the same time, moderate exercise in the fresh air is of great advantage, but the patient should be admonished not to overtax the strength, mental or physical, and rest as soon as the palms of his hands become moist. Change of air and scene, as well as pleasurable but moderate excitement, such as theatres, concerts, etc., aid in a great measure in hastening complete recovery; while, on the other hand, quinine, antipyrin, phenacetin, and all the list of antipyretics and analgesics invariably retard recovery in the chronic form of the disease, and often produce death in the acute form by their debilitating action on the heart.

CHRONIC HYPERTROPHIC RHINITIS.

BY RALPH W. SEISS, M.D.,

Adjunct Professor of Otology, Philadelphia Polyclinic.

Etiology.—The direct causes of chronic hypertrophic catarrh have not been satisfactorily established, nor has its very variable course in different individuals been altogether logically explained. The proximate etiological factors are vaso-motor disturbances, the gouty diathesis, and generally defective nutrition and resistance.

A large proportion of cases of rhinitis are dependent on what might be called *central* causes, the original lesion or condition being in the vaso-motor system, and associated with characteristic symptoms referred to other organs. Such patients are more or less “nervous” and neurasthenic, with strong tendencies towards cardiac irritability and general circulatory disturbances; the action of the skin is seldom normal, and cold extremities are much complained of. The condition present in such cases may be called a *vaso-motor neurosis*, and may be aggravated or even produced by purely mental causes, such as overwork or emotional excitement.

Gout, whether inherited or acquired, is exceedingly apt to produce inflammatory lesions in the upper air-passages, hypertrophic catarrh being one of the commonest manifestations. Lithæmic rhinitis is usually associated with chronic tonsillitis, laryngitis, or conjunctivitis, and each area of inflammation shows an especial proneness to acute exacerbations, which are usually accompanied by gouty symptoms referred to other organs.

Defective nutrition, especially the atonic condition which follows diphtheria and the eruptive fevers, seems to be the sole cause of certain cases of nasal catarrh, and to be responsible for the peculiar vulnerability of the Schneiderian membrane which is present in certain subjects.

Local causes may produce nasal catarrh, or increase the disease when dependent on constitutional factors. Structural peculiarities, such as deflection of the nasal septum or deformity of the turbinated bones, are the origin of this disease in a few cases, *pressure-irritation* being the immediate cause. A long list of substances, prominent among them particles of wool, stone, or metal, are exceedingly injurious if inhaled as dust, and aggravate or cause hypertrophic rhinitis in nearly all persons who are exposed to such laden atmosphere.

Heredity also bears a strong causative relation to this disease, especially

to the sclerotic type, and it is a pathological fact that many cases of nasal inflammation commence during the intra-uterine life of the individual.

Pathological Anatomy.—Chronic hypertrophic catarrh is readily divisible into two stages: *a*, the period of dilatation of the venous sinuses (*vaso-paresis*); *b*, the period of fibrous metamorphosis (*sclerosis*). In the first phase of the disease the venous channels are widely dilated from complete relaxation of their walls, and the turbinated bodies are consequently much enlarged, even to the extent of completely occluding one or both nasal chambers. The swollen tissue is soft and sodden, showing but little elasticity when pressed upon, the probe simply sinking into the relaxed tissue as into an cedematous area, the sulcus formed slowly filling up again as the pressure is removed. Under the microscope the sinuses are found to be widely dilated, and in the section usually filled with clotted blood; there is always an extensive infiltration of leucocytes, with a tendency to fibroblastic organization of the same into new connective tissue.

The second or sclerotic stage may be found side by side with areas of simple dilatation, or it may involve the entire intra-nasal region of one or both sides; it is quite common to find the vaso-paretic and the fibrous stage of the disease affecting opposite sides of the nose at the same time; one turbinal showing dilatation only, while the other exhibits gross fibroid changes.

The period of fibroid metamorphosis is marked by more or less density of the turbinated tissues, and the surface of the membrane is usually very irregular, nodular or bosselated. Ecchondroses of the nasal septum are of very frequent occurrence, especially at the extreme anterior lower border of the cartilage, or a long ridge may extend the length of the septum. Frequently the turbinated body will be found to be markedly grooved by a corresponding ridge projecting from the cartilage, although a considerable interval of clear space may intervene at the time of examination; showing conclusively that during the first stage of the hypertrophic process (*vasomotor paresis*) the turbinal pressed against the nasal septum. Microscopically the erectile tissue is found to have undergone more or less complete sclerosis, the vascular sinuses being obliterated or occurring only adjacent to the periosteum. There are four modes of obliteration of the turbinated sinuses:¹ 1, by contraction of the newly-formed fibrous tissue; 2, by invasion of the sinuses by masses of leucocytes; 3, by the formation of connective-tissue "buds" in the cavities; 4, by the formation of thrombi within the sinuses.

The first two processes are those common to any chronic inflammation. The formation of the "buds" or septa is of great pathological importance; in some sections half the sinuses will contain "buds" of fibrous tissue, more or less completely blocking up their lumen. (Fig. 1.) Their growth is due to the puckering of the sinus-walls from the general contraction, plus

¹ J. N. Mackenzie, New York Medical Journal, August 22, 1885.

the persistent irritation and hypertrophy of fibroid tissue which are present. The formation of parietal thrombi, discovered by Mackenzie, of Baltimore,

is what might be expected from the active blood-vessel changes which are taking place. They are probably common in those exceedingly rapid cases of nasal catarrh in which the grade of chronic inflammation is of an acute type.

It will at once be seen that these phenomena can bring about but one result, the conversion of the affected turbinated tissue into a fibrous mass. Tissues other than the vascular sinuses are synchronously affected. The pressure exercised by the new growth induces atrophic changes in the glandular structures, which are

FIG. 1.
SECTION OF SCLEROSSED TURBINATED BODY.—a, "buds";
b, b, inflammatory small cells; c, c, general fibrous tissue;
d, vascular sinus.

finally destroyed; the ordinary nutrient blood-vessels are also constricted, and the vicious circle of changes goes on until, in extreme cases, the lower turbinated body may be represented by a mass of mere scar-tissue.

Early in the pathological history of sclerotic rhinitis, changes in the epithelial layer take place, shedding and proliferation, and later in the process the formation of hypertrophic *papillæ*. It will frequently be observed, when examining cases of long-standing rhinitis, that the mucous membrane covering the scroll-like bodies has a coarsely velvety or very minutely bosselated contour; this appearance is due to the growth of *papillæ* from the mucous membrane,—multiple "papillomata" of very minute size springing from the surface of the turbinated tissue. (Fig. 2.) The structure of these projections is precisely that of the so-called typical papillomata; they are made up of vascular connective

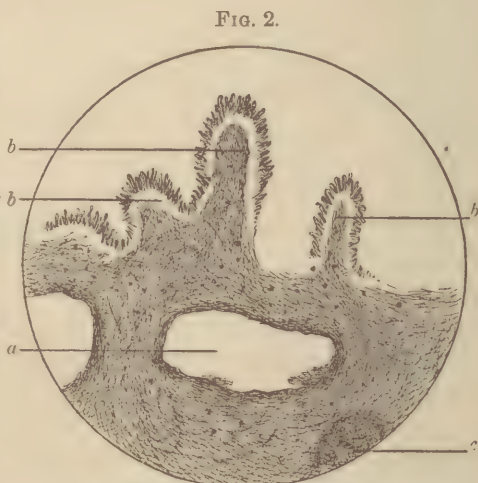


FIG. 2.
SECTION OF TURBINATED BODY IN COMMENCING SCLEROSIS.—a, vascular sinus; b, b, b, papillæ on mucous membrane; c, vascular sinus full of blood.

tissue capped by layers of epithelium, the blood-vessels being frequently numerous and forming vascular loops. These minute papillomata may

undergo atrophy, the surface of the turbinated body becoming smooth and glassy, or they may persist indefinitely. Clinically, their importance is doubtless considerable, as they must add to the always present septic condition by entangling morbid products and increasing the difficulty of clearing the nose either by blowing or by medical means.

The pathological processes at work will be seen to be the *fibro-blastic* changes common to all chronic inflammations, the persistent migration of leucocytes and their organization into new connective tissue being the essential characteristics of hypertrophic rhinitis: much stress will be laid upon this fact in considering the treatment of this disease.

Cartilaginous and bony outgrowths from the septum are of much pathological importance in the disease under consideration, both as effects and as causes. In structure they consist of cartilage or of osseous tissue, or frequently of mixed elements, spicules of bone occurring in the centre of hyaline areas. These tumors are the result of chronic perichondritis and periosteitis, and are to be regarded as local inflammatory hyperplasiæ. Not infrequently they act as serious complicating factors in the disease, by occluding respiration and pressing injuriously upon surrounding areas. It is of importance not to confound these growths with deflections of the septum narium, the consideration of which does not belong to the present article.

Intra-nasal hypertrophies are prone to undergo myxomatous and papillomatous changes, in the first instance forming the soft or "mucous polypus," in the second the dendritic post-nasal tumors so common in long-standing cases of nasal catarrh. Myxomatous degeneration occurs in subjects in which the inflammatory condition has been active in type and of long continuance, especially in forms of rhinitis characterized by much hypersecretion; "necrosing ethmoiditis" as a cause of "mucous polypi" is not admitted by the writer. The anterior extremity of the middle turbinated body is especially liable to this form of degeneration when hypertrophied, becoming much enlarged, bossellated, and soft and gelatinous in consistence. Under the microscope such tumors show all the elements of the hypertrophied mucous membrane, and in addition an irregular net-work of fibrous tissue holding a structureless mucoid material in its meshes; inflammatory cells are always abundant throughout the degenerated tissue. Nasal papillomata were described by the writer more than three years ago,¹ and have since been recognized by many rhinologists as a constant factor in nasal catarrh. This form of degeneration is most common in posterior hypertrophies, the surface of the enlargements becoming much ridged, roughened, and wart-like; the process consists of a hyperplasia of the epithelial layer, the cells proliferating and forming dendritic masses made up of aggregated epithelial cells which rest upon a base of vascular connective tissue. This thick protecting layer of epithelial cells makes it almost impossible to affect such enlargements by local appli-

¹ American Journal of the Medical Sciences, February, 1889.

cations until the surface epithelium has been removed by curetting or other surgical means.

Symptoms.—During the first stage of hypertrophic rhinitis, when the venous sinuses are widely dilated, the symptom of which patients most complain is usually nasal *stenosis*. Respiration through both nostrils is seldom or never free, and complete occlusion of both nasal chambers is common; as a result, the pharynx becomes more or less dry and irritated, still further increasing the discomfort of the patient. A little later in the course of the disease, *hypersecretion* is the source of much annoyance; a portion of the excessive nasal mucus drains forward and is blown out through the nostrils, or in neglected children trickles in a disgusting manner down the upper lip, but the greater quantity flows backward and down the pharyngeal walls, when it is expectorated or swallowed. As the disease progresses, frontal headache becomes a prominent symptom in many cases, and signs referable to various complications give more or less discomfort.

In the second or sclerotic stage a somewhat different and much more extensive group of symptoms is presented; rarely is there either hypersecretion or nasal stenosis, though the first may be found in cases in which myxomatous changes have taken place, and large septal enchondroses may cause the latter. Dribbling of thick, tenacious mucus from the posterior nares—from the diseased pharyngeal tonsil—is common, and is often most bitterly complained of. Frontal headache from congestion of the frontal sinuses, and irregular and frequently severe head-pains from implications of other bony sinuses, are frequently the cause of patients' presenting themselves for treatment. The sense of smell is blunted, and taste is, consequently, frequently much impaired. The chronic pharyngitis and laryngeal implications always present give the symptoms characteristic of these conditions.

The laryngitis, tracheitis, and even chronic bronchitis, so frequently found in advanced cases of this disease, are directly symptomatic of the nasal lesions. As Bosworth has so well shown, the turbinated bodies are almost the sole source of the moisture needed to saturate the inspired air (about five thousand grains of water in twenty-four hours). When from sclerotic disease the "erectile tissue" is unable to throw out the proper amount of moisture, the inspired air reaches the bronchi in a dry and unprepared condition, with the result of irritation of the mucous membrane of the lower respiratory tract and the lighting up of other grave forms of disease.

Of remote symptoms, languor, nervous irritability, and a variously described feeling of abnormality "in the head" are the commonest. Asthma, or at least violent panting after slight exertion, is frequently complained of. Patients in whom the scroll-like bodies are represented by mere scar-tissue have invariably, in my experience, been much below par, complaining of various neurasthenic indications, general ill health, and a great variety of symptoms. The conjunctivæ are usually injected, and when referred to an oculist gross eye-changes are generally reported present. Ocular neuralgia and various forms of asthenopia are not uncommon complications, and are

often directly due to the nasal lesions, the eye-symptoms being controlled only by efficient treatment directed to the nose; myxomatous degeneration seems especially prone to produce ocular neuroses.

The Eustachian tubes and middle ears are always involved in prolonged cases of this disease; impairment of hearing, tinnitus aurium, aural vertigo, and what may be called ear-malaise are very frequently complained of, and aural sclerosis, with extreme deafness, is one of the results of this disease in some cases. The glossal papillæ are enlarged and diseased, and dyspepsia is a common concomitant. Mental symptoms have been noted by many observers: the writer's experience has led him to believe them always dependent on the secondary ear-lesions; where deafness and tinnitus have not appeared, the mind will be uninfluenced. Lastly, sleep-disturbances and insomnia, whatever relation they may bear to the nasal lesions, are of the commonest occurrence in this disease.

Inspection.—The results of examination in this disease differ widely according to its stage, the age of the patient, and the extent of the various complications. During the stage of sinus-dilatation and early fibrous changes anterior rhinoscopy shows the nasal fossæ to be more or less occluded by soft and spongy or somewhat elastic enlargements, situated usually on the lower but occasionally on the middle turbinated body. The best form of nasal dilator is largely a matter of taste, nearly every model in the market having its advantages as well as advocates; the writer believes the form figured below to be the most generally useful one, giving the most extensive view with the least discomfort to the patient. (Fig. 3.) These swellings are easily reduced by pressure with a flat probe, the engorged sinuses being emptied temporarily of blood, and slowly filling again as the pressure is removed. A similar but much more lasting effect is produced by lightly brushing the swollen areas with a five-per-cent. solution of cocaine muriate, the blood-vessel contraction speedily producing a local anæmia, with consequent diminution of the overgrowths.

By posterior rhinoscopy somewhat similar enlargements are found to occupy the posterior nares; they appear as smooth dark-red masses jutting from the lower turbinal or the floor of the nasal fossa. The mucous membrane about the orifices of the Eustachian tubes is usually much swollen and reddened, and the pharyngeal tonsil is abnormally prominent in most cases. It should not be forgotten that if the lower pharynx has been cocaineized to facilitate the use of the rhinoscopic mirror, both swelling and redness will have largely disappeared from the extension of the effect of the drug.

Later stages of hypertrophic rhinitis present much more marked structural changes; anteriorly we find the scroll-tissues to be lighter in color and much more dense in consistence than in preceding



FIG. 3.
Kramer's nasal dilator.

stages. There is frequently a certain amount of stenosis, but this is exceptional, occurring generally in cases in which ecchondroses of the nasal septum, deviations, or bony enlargements have occurred. Probe-pressure or cocainization shows the hypertrophies to be made up of elastic (fibrous) tissue containing but few venous sinuses. Cartilaginous outgrowths, enlargements of the anterior nasal spine of the superior maxillary bone, and bony spurs from the vomer are very frequent in this stage of rhinitis, and appear as hard, firm ridges or nodes distributed over the anatomical areas named. The middle turbinated body has undergone enlargement at its anterior extremity in many cases; it is commonly compact and fibrous in consistence, and may be so large and hard as to be firmly jammed in the nasal lumen. In advanced cases these nasal fibromas of the middle turbinated tissue frequently undergo myxomatous degeneration, and are then soft and gelatinous, giving the appearance of a sessile polypus. In other cases the middle scroll is extensively atrophied, and has a thin, pinched, blade-like appearance.

Posteriorly, as shown by the rhinoscope, the general mucous membrane has undergone thickening and fibroid change; the membrane is very light pink or yellowish in color, hard and dense in appearance and on testing with the laryngeal probe. The lips of the Eustachian tubes may be entirely yellow, and quite hard from fibroid change. There are usually sessile, or more rarely pedunculated, posterior hypertrophies; small, usually much corrugated, masses jutting from the floor of the nose, from the extremity of the lower turbinated body, or least usually from the bony septum. They are white or yellow, firm and elastic in consistence, and are oftenest somewhat symmetrically distributed.

Their surface is usually exceedingly rough and dendritic, this condition being due to the papillomatous changes previously described. Flakes of thick, adherent white or yellow mucus will frequently be found sticking to the turbinals or Eustachian prominences, and may thickly coat the posterior pharyngeal wall. Characteristic secondary lesions occur in the region of Luschka, in the lower pharynx, and in the larynx, which will be found described in the appropriate sections.

Treatment.—The therapeutic measures at the command of the modern rhinologist are the use of medicines in solution as sprays or pigments, and their application in the form of powders by means of various forms of insufflators; localized applications of chromic and trichloroacetic acids or of other caustics; electricity in the form of both constant and interrupted currents and the galvano-cautery. Special surgical methods are also required in a large number of cases, for the performance of which very various forms of snares, curettes, forceps, and knives have been devised. Constitutional and hygienic treatment is also indicated in nearly all cases of nasal catarrh.

In the early stages of hypertrophic rhinitis, spray applications, if selected and applied with judgment and skill, have almost a specific effect in arresting

the disease and removing the unpleasant symptoms. A thoroughly good atomizer is essential to secure satisfactory results; *a fine, abundant, regular spray, free from jets or large drops*, and ease and reliability in manipulation, are the characteristics of a good instrument. Not a few of the advertised atomizers are absolutely worthless, and too much care cannot be taken in making a selection. The hand-bulb answers very well if the operator possesses strong and well-drilled hands, but a reliable air-compressor is far more satisfactory to both doctor and patient, and is absolutely necessary if the operator is not more than ordinarily muscular. There is a large variety of forms in the market from which a selection may be made, the choice being largely a matter of taste. For nasal treatment a pressure of from eight to twelve pounds is required; a weaker spray than the former is hardly sufficient to clear the nasal chambers thoroughly, and a pressure of over twelve pounds frequently causes epistaxis, and may be very injurious.

A very large variety of formulas have been suggested for use in chronic rhinitis, of which the following are among the most generally useful:

R Ext. hamamelidis destil.,
Aquæ rosæ, āā f ℥ ij.—M.
Sig.—Use in atomizer.

R Listerinæ (Lambert), ℥ iv;
Sodii bicarb.,
Sodii boratis, āā gr. viii;
Aquæ rosæ, q. s. ad f ℥ iv.—M.
Sig.—Use in atomizer.

Solutions of boric acid (gr. x to f ℥ j), of sulpho-carbolate of zinc (gr. ii to iv to f ℥ j), and of resorcin (gr. v to f ℥ j) are also of great value in selected cases, the especial efficacy of any one combination being often a matter of experiment, or of the "intuition" born of long experience. Whichever spray be selected, it must be applied with care and thoroughness under the fullest illumination and inspection; the treatment should at first be made two or three times per week, rapidly increasing the intervals as the vasoparesis diminishes and the blush and swelling subside. Solutions in oil may be substituted for the aqueous fluids, and in certain cases of great irritability act better than the latter compounds. *Liquid albolene* is the most satisfactory base which has been tried by the writer, but *glycoline* and *benzoinol*, as well as numerous other oils now in the market, have practically the same properties. Various drugs may be used in such solution, among the most useful being oil of eucalyptus, oil of sassafras, oil of pine-needles, camphor, and especially menthol; any of which may be used in the strength of from two to six grains to the ounce of the chosen base. Local therapeutic measures may have to be continued for from three or four weeks to as many months, and must be accompanied with efficient treatment directed to the always present pharyngeal and laryngeal compli-

eations, for consideration of which the reader is referred to other sections of this work.

In cases of moderate fibrous thickening, applications of diluted iodine to the turbinated bodies is a very valuable measure; solutions of the crystals (gr. x combined with potassium iodide, gr. xl) in pure glycerin may be used, or from one to five drachms of tincture of iodine with glycerin to make an ounce may be substituted. A very light steel aural applicator makes the best instrument for this purpose, a small mop of cotton being wound on its roughened extremity. Care should be taken not to brush the iodine over the floor of the nasal chamber or the septum, increased irritation without corresponding benefit being the result of such lack of manual skill.

When the post-nasal space is obstructed by thick and glairy mucus, requiring violent efforts in hawking and blowing on the part of the patient to dislodge it, the up-curved post-nasal atomizer serves a very valuable purpose. The effective use of this instrument demands a considerable degree of manual skill, it being somewhat difficult to avoid injuring the palate or bruising the posterior pharyngeal wall. The nozzle of the atomizer must be carefully introduced and the palate gently lifted upward; the posterior nares are then gently sprayed until the patient's limit of toleration is reached, efforts at retching or choking being a signal for immediate withdrawal of the instrument.

Should the above treatment, when combined with proper constitutional and hygienic measures and proper management of the lower respiratory tract, not prove sufficient to remove the symptoms, and stenosis and hypersecretion continue, more energetic measures are required. Soft and vascular enlargements are best removed by the use of chromic acid, used *not* as a general escharotic, but according to a very definite technique. The area to be operated upon is first to be fully contracted and anæsthetized by the use of a five-per-cent. solution of cocaine muriate: the usual method of applying the alkaloid is to saturate a small pledget of cotton with the solution and tuck it up between the septum and the surface of the turbinal by means of a delicate forceps. After the cocaine has remained for from five to ten minutes, the chromic acid is to be used on a firm but very delicate probe in the form of a fused bead, or a few crystals may be made to adhere to a small, tightly-wound cotton tuft by slightly moistening it with water. The latter method is exclusively employed by the writer, and is believed to possess many advantages; the charged portion must not exceed two millimetres in diameter. The acid having been prepared, the cocaine pledget is removed and the applicator carried to the point of greatest hypertrophy, and held firmly in contact with the mucous membrane for fifteen or twenty seconds. Very marked contraction of the turbinated tissue at the line of contact results, together with a slough of shallow depth, the final and speedy effect being to bind down permanently and firmly the redundant tissue. A few seconds after using the acid the nares should be sprayed with

Dobell's solution or some other alkaline formula, to prevent its spreading; the poisonous properties of the chromates, even in very minute doses, must not be forgotten, and proper care must be exercised. The cauterizations may be repeated until physiological respiration is secured, from seven to twelve days being allowed to elapse between the applications, sedative sprays being employed during the intervals. Some rhinologists are much prejudiced against the use of this acid, and regard it as very irritating and injurious; the writer has found it most satisfactory if used in small quantities as above, but altogether unsuited for *extensive* destruction of nasal tissue. Trichloroacetic acid is strongly advocated by Ehrmann and J. W. Gleitsmann, who assert that its use is followed by almost no inflammatory reaction, and that the eschar formed is peculiarly dry and aseptic. It is best used on an aluminium rod which has a shallow excavation or pocket at its distal extremity to hold the dry acid; otherwise the technique of its use is identical with that directed for chromic acid.

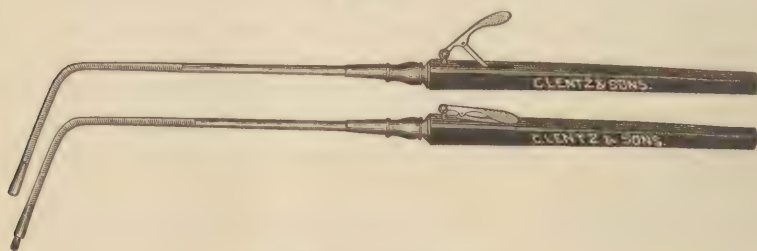
In the second stage of chronic hypertrophic catarrh, where fibro-blastic changes have caused advanced changes in the turbinated tissues, more energetic means are required to reduce enlargements. The pathological processes at work must not be forgotten, and the fact that "cicatricial" contraction has already commenced in these hypertrophies must influence the surgeon in deciding on the means to be employed, operative measures, if in the least overdone, causing sclerosis and atrophy, most pernicious to the patient. If respiration be seriously embarrassed or the normal functions of the nasal chambers otherwise interfered with by fibrous enlargements, their removal by the galvano-cautery or the Jarvis snare is indicated. The variety of cautery batteries now in the market permits of each surgeon consulting his individual taste, the various forms each having a following of eminent teachers; probably the various forms of storage battery, such as that of Metcalfe, have at present the preference. Knives of various shapes are required for different cases, the most generally useful being the flat blade six millimetres long by three wide.

The reduction of a fibrous hypertrophy by the cautery having been decided upon, the turbinal is to be first thoroughly cocaineized as for the application of chromic acid, the cautery blade is then introduced through a suitable speculum under perfect observation, and a shallow slit burned in the turbinated tissue. The knife should always be introduced cold, and heated to a bright cherry red by closing the circuit when in contact with the mucous membrane; it is then drawn forward, making an incision of the required length and depth. Unless the patient is perfectly under control and the operator an expert, it is safer to protect the septum by means of a small piece of bristol board cut to fit and introduced before the cauterization, a thread being passed through the card and allowed to hang from the nostril, assuring its easy removal. The subsequent course of a cautery incision is usually perfectly favorable, pain, hemorrhage, or inflammatory reaction being rather exceptional. If the first symptom occurs, it is usually

because either the periosteum or the septum has been burned ; both of these accidents, if at all extensive, are evidences of very bad surgery indeed. Slight bleeding results in a small percentage of cases, and is easily controlled by holding a small piece of ice to the nose and keeping the head in an upright position. Quite annoying hemorrhage occasionally results from removal of the eschar, either by its being dragged off by the cautery blade, owing to the latter being allowed to cool off while in contact with the burned surface, or from some other cause. In such cases the naris should be carefully plugged with a strip of gauze or patent lint, which in obstinate hemorrhages may be dusted with tannic acid. The patient should invariably be cautioned against forcibly blowing the nose or indulging in any form of violent exercise for at least twenty-four hours after the operation.

The number of cautery incisions required to reduce a firm fibrous hypertrophy varies from one to four ; from one to three weeks being allowed to elapse between the burnings. It is the practice of the writer to see patients each second or third day after the operation in all cases, and to treat the nasal membrane thoroughly with antiseptic and sedative sprays.

FIG. 4.



MacCoy's guarded applicator.

Any inflammatory reaction or sepsis is thus prevented in nearly all cases, and the burn heals much more rapidly than if allowed to run its course without further treatment.

The use of acids or the galvano-cautery for the ablation of *posterior* turbinated hypertrophies, especially when situated close to one of the Eustachian orifices, I regard as of doubtful utility. It should certainly never be undertaken by any but a skilled expert, and the surface burned should be the smallest compatible with good results. The applicator used should be a guarded one in all cases, that of Professor MacCoy being the most generally useful. (Fig. 4.) Acute Eustachian salpingitis, with subsequent inflammation of the middle ear, often of a purulent and destructive character, is a very common complication of such cauterizations, and it is the opinion of the writer that the destruction of simple post-nasal enlargements should be undertaken with great reluctance. The curette and the cold-wire snare are far safer instruments for this purpose than acids or the actual cautery in any hands, and the only measures admissible to any but the highly skilled.

Curetting posterior hypertrophies to bring about their partial or complete disappearance was introduced by the writer nearly five years ago, and is regarded by him as a very valuable procedure. Post-nasal enlargements, when dense, light-colored, and rugose from papillomatous changes, cannot

FIG. 5.



Seiss's straight curette.

be reduced by any medical means, and, the operation of snaring being a somewhat painful and protracted one, curetting is the simplest form of efficient treatment. The instrument usually employed is a simple straight curette four and one-half inches long from edge to handle, the ring well bent on the shaft and measuring five by ten millimetres. (Fig. 5.) The parts being anæsthetized by a five-per-cent. solution of cocaine, the instrument is introduced through the nose, and, guided partly by the rhinoscopic mirror and partly by the sense of touch, the growth is gently scraped over its entire surface until the epithelial layer is removed. Very slight hemorrhage results if the operation is properly done, and subsequent inflammation is quite unusual. The hypertrophic mass undergoes great subsequent contraction, and is usually sufficiently reduced in from one to two weeks after the operation; a second curetting is required in rare instances only.

Anterior hypertrophies when of very large size, and all posterior growths requiring operative treatment other than the curette, are best removed by the Jarvis snare. (Fig. 6.) This is, after the cautery blade, the most valuable instrument used in nasal surgery; its successful use, however, demands great care and a large amount of skill and special experience. It must never be forgotten that the turbinated bodies are *organs* with a very definite sphere of usefulness, and that upon their integrity largely depends the condition of the lower respiratory tract. Their even partial removal must therefore never be undertaken without a full consideration of the final results of the operation.

The technique of snare-manipulation varies so much in every case that

FIG. 6.



Jarvis's snare (straight).

general directions have only a limited value. The loop of wire should never be so large that a portion of it projects beyond the end of the snare after the milled wheel has been run down to its fullest extent; this and improper fastening of the ends of the wire are the commonest ways of mis-

using the instrument. A growth having been engaged in the loop of the snare, the nut is turned rapidly until the mass is tightly grasped, after which it is to be rotated one turn at intervals of from one to five minutes until the mass is cut through. Anterior hypertrophies require about one-half hour for their satisfactory removal, and posterior growths at least one hour if a bloodless operation is to be secured. Myxomatous masses can be rapidly cut through, these growths being but sparsely supplied with blood-vessels or nerves. Posterior new growths can be grasped only by the aid of the rhinoscope, the mirror being held in the left hand while the snare is manipulated through the nose by the right. The operation is easier to describe than to perform, and should not be attempted by a novice unless under the immediate direction of a skilled operator. Cocaine anæsthesia has to be omitted in many cases of post-nasal growths, the great tissue-contraction which it causes making it impossible to grasp the masses with the wire after its use. In view of these difficulties it is a satisfaction to remember that the great majority of posterior hyperplasiæ contract sufficiently under milder measures, and that operative interference is indicated only when such methods have failed and where annoying symptoms still persist.

Myxomatous tissue resulting from the degeneration of turbinated hypertrophies is very easily removed; the snare is the better instrument in all cases in which the mass can be engaged in the wire loop, but when situated high up in the nasal fossa some form of biting forceps may be required. The latter is by no means a perfectly safe implement, severe hemorrhage, reactive inflammation, and constitutional depression frequently resulting from its too energetic use. It is better to gnaw away the myxomatous tissue piece by piece at several sittings than to set up "necrosing ethmoiditis" by too radical surgery.

Nasal polypi—usually adenomata—are not uncommonly found in advanced cases of hypertrophic catarrh, and should be removed with the snare; the base of the growth may be subsequently seared with the cautery blade to prevent recurrence. Allen's or some similar form of polypus forceps is occasionally needed to secure growths situated about the hiatus semilunaris, etc., but such instruments are to be used only under full illumination and observation; the older methods of tearing out polyps with the forceps, guided only by the sense of touch, being at the present time inexcusable.

Cartilaginous and bony outgrowths from the septum require removal in rare instances only. It should be made a rule that no operation on the triangular cartilage or the vomer should be undertaken when any procedure on the soft parts can be made to take its place. The writer's emphatic opinion, formed more from observing the work of others than from his own, is that all operations on the nasal cartilage are highly uncertain in their results. The vascular supply being limited to the perichondrium, healing takes place only from the edges of a cut surface, and as a consequence rapid reformation of hyperplastic cartilage cells and local necrosis are common

results. The former process not infrequently results in the formation of a node larger than the one removed, or in rarer cases perforation of the septum may result from necrosis.

When, however, nasal ecchondroses seriously interfere with respiration or produce unpleasant symptoms by pressing upon surrounding parts, their careful removal becomes expedient. It is for this class of operations especially that a long list of fearful implements of torture has been devised by progressive rhinologists. Electric engines, dental engines, powerful chisels to be struck by a fair-sized hammer, saws large and strong enough for a cabinet-maker, with gauges, burrs, and knives of every degree, have been invented, and are, alas! very largely used in these operations. The writer can only say in regard to them that he could never be convinced that such heavy tools are suited for use in one of the most delicate regions of the body, or that the end to be secured in the least justifies the means employed. In his own practice the only instruments used to remove ecchondroses or bony new growths are sharp- and probe-pointed tenotomes, made somewhat stronger and longer in the shank than the ordinary forms (Fig. 7), angular scissors, and the lightest and most delicate pattern of Bosworth's nasal saw. It having been decided that the removal of a dense mass situated on the septum is necessary, the parts are cocaineized as already described; the chosen knife is then introduced beneath

FIG. 7.



Seiss's septum knife.

the node, which is cut through from below upward to the level of the septum. If osseous tissue be encountered, a few strokes with the saw serve to divide it, after which the piece can be lifted out with forceps and any rough edges trimmed with the scissors. Deflections of the septum narium must not be confounded with the spurs under consideration; their management does not belong to the present paper. Hemorrhage is not usually very profuse after such operations, plugging the nose being rarely required; the patient must, however, be carefully instructed what to do in case of accident. Bony spurs from the vomer are to be sawn off from below upward in the same manner as the softer growths; bleeding is usually rather profuse in such cases. The dental engine may possibly be of service in very skilled, cautious hands in the case of large bony masses.

The after-treatment of all nasal operations is of much importance. The manipulation being completed, the nares should be carefully and thoroughly sprayed with some antiseptic and sedative solution: the following form of Dobell's solution is very satisfactory:

R Acid. carbol. (cryst.), gr. viii ;
 Sodii boratis,
 Sodii bicarbonatis, aa gr. x ;
 Glycerini, fʒ ij ;
 Aquæ destil., q. s. ad fʒ iv —M.
 Sig.—Use in atomizer.

Slight hemorrhage may be arrested and additional antiseptis secured by blowing a small quantity of *bolted* subcarbonate of bismuth over the region of the wound ; a small percentage of iodoform may be added if the odor is not objected to. The patient should be seen daily until the wound is covered by a non-absorbent scab, and the nares treated as above ; home spraying is seldom ordered by the writer, the jet being very apt to occasion return of hemorrhage if unskilfully used. The course of all operations on the septal cartilage is exceedingly slow, and often far from satisfactory, even under the best treatment. Healing takes place from the edges only, and the wound left by the removal of a small ecchondrosis may occupy three weeks or more in fully cicatrizing.

When fibro-blastic changes have progressed so far that much of the turbinated tissue has become almost tendinous in structure, the results of treatment are naturally far less propitious than in the earlier stages of the disease. The most favorable prognosis that can be given is that a large degree of comfort can be secured and the progressive disease arrested by continuous treatment. The rule of most importance in this type of hypertrophic rhinitis is that no form of therapeutics shall be employed which may occasion any fresh migration of leucocytes, the connective tissue formed from such wandering cells being the most important pathological condition in the disease.

The treatment may again be divided into medical and surgical measures. The use of "alteratives" in spray is of great value ; the sulpho-carbolate and the iodide of zinc, solutions of thymol or of "listerine," and Boulton's solution have proved the most valuable in the writer's hands ; they must be applied with skilful and thorough technique, at first daily, and towards the end of the four, ten, or fourteen months of treatment, once a fortnight.

The action for good of these and similar medicines in this stage of nasal catarrh is partially due to their antiseptic and mechanical as well as to their stimulant properties. Their first action, if properly used, is to cleanse mechanically and render antiseptic the nasal chambers ; secondarily, the blood-vessels are so affected that the local blood-supply is increased, the whole tone of the turbinated bodies being thereby improved. The mucous glands are also stimulated to throw off the proliferated cells and abnormal mucus which clog them, and the condition of the nasal cavities becomes for a longer or shorter period more nearly normal. More energetic stimulation is frequently called for ; Seiler's iodine solutions, and tincture of myrrh or sanguinaria diluted with glycerin to suit the individual case, are

perhaps the most valuable; both are to be applied with the cotton-tuft and carrier under full illumination and inspection.

Faradism is a very valuable stimulant in cases of advanced rhinitis; a straight nasal electrode long enough to reach the pharyngeal wall when introduced through the nostril is required. The tip of the instrument being well wrapped with cotton and moistened with some alkaline solution, it is attached to the positive pole of the battery, the negative—an ordinary sponge or metallic rheophore—being held in the hand of the patient or applied to the maxillary or laryngeal regions externally. Much care is necessary in regulating the strength of the current and the length of the sittings; the former should never be sufficient to irritate or tire the patient. The applications should not at first exceed a few minutes in length, and ten minutes is the outside limit to which the séances should be carried.

Surgical treatment in the sclerotic stage of chronic rhinitis should be generally limited to the removal of myxomatous and papillomatous degenerated tissue, the snare or curette being employed as already described. A sort of massage of the turbinated tissues by means of a large-headed probe has lately become rather a routine measure with the writer. It has certainly appeared to do good in many cases, restoring circulation, ridding the surface of crusts, and occasionally causing some increase in size of the turbinated bodies. It is at least harmless in cautious hands, and is based upon well-known and scientific principles.

In all stages of nasal catarrh accompanying diseases of the adjacent sinuses act as complicating factors in a certain proportion of cases, and must receive due attention to secure good therapeutic results. They will be found considered in another article.

The constitutional and hygienic treatment of chronic hypertrophic rhinitis is also of much importance; "catching cold" always seriously aggravates the disease, and must be carefully guarded against, and all exciting causes must, if possible, be discovered and removed. General hygienic measures may be included under exercise, bathing, clothing, and local hygiene. Vigorous "training" is an especially valuable means of controlling the catarrhal tendency; horseback-riding is one of the best exercises for the purpose. Regular and frequent bathing, combined with daily cold sponging of the face, neck, and chest, is decidedly beneficial in preventing colds, but in cases where the vaso-motor system is much below par, considerable caution is necessary. Cold *plunge*-baths are very dangerous things for weak and catarrhal subjects, and should be forbidden, at least during the winter months. Energetic friction with either a plain rough or a "salted" towel should invariably follow the bath, and should be continued until the skin is well reddened. The clothing of all catarrhal cases must be carefully looked after, and sufficient protection at all times secured. Local hygienic measures include the avoidance of dust-laden air or an atmosphere charged with smoke or any other irritant, or the wearing

of a respirator if such conditions must be encountered. *Forceible* efforts to clear the nostrils by blowing or hawking are always injurious, frequently causing capillary hemorrhages and ecchymoses, and increasing the general irritation.

Constitutional treatment by means of medicines is a necessary measure in many cases of the disease under consideration. It should be remembered that the gouty diathesis is the causative factor in numbers of cases seen in private practice; it demands the treatment proper for that condition. Anæmia and neurasthenia seem to be concomitants of nearly all severe cases of chronic rhinitis, and call for proper therapeutic management. Quite a number of drugs are supposed to act directly upon the mucous membrane of the respiratory tract when taken internally, such as cubebs, grindelia robusta, crude petroleum, etc., but their efficacy is very doubtful. Sodium bromide and ammonium chloride are, however, useful drugs in many cases of hypertrophic rhinitis, and add decidedly to the good results of treatment; strychnine also acts well by improving both the general and the local circulation.

HYPERTROPHY OF THE PHARYNGEAL TONSIL.

This condition, although it may be regarded as simply a complicating factor or a sequel of certain types of chronic hypertrophic rhinitis, presents so many peculiar features that it is best considered in a separate section. The causes are much the same as those of hypertrophic catarrh, but the element of defective nutrition plays an especially important part, and the peculiar depression which follows scarlet fever, diphtheria, measles, etc., is the immediate cause in very many cases of enlargement of the pharyngeal as of the faucial tonsils. Harrison Allen¹ thinks the formation of pathological tissue may be due to abnormal venous anastomosis from failure of bony union between the sphenoid and adjacent bones. It is a disease of the young in nearly all instances, being principally confined to children under ten years. Heredity plays an important rôle, most cases among the intelligent classes having a distinct history of "weak throats" and catarrhal conditions for at least two generations. Like hyperplastic enlargement of the faucial tonsil, the *adenoid tissue* of the pharyngeal vault tends to undergo atrophy after the age of puberty; it may, however, persist or possibly even make its first appearance in middle life.

Chronic hypertrophy is met with of two fairly distinct varieties.² In the first the growth is soft, friable, and spongy, and appears as irregular "papillomatous" projections or "stalactites." The second variety, which is the form most often met with by the writer, presents more of the characters of a well-defined tumor. Its surface is smooth, and the base may be somewhat constricted; in consistence the mass is comparatively

¹ A Clinical Study of the Skull. Toner Lectures, No. 10, p. 27.

² Delavan, Transactions of the American Laryngological Association, 1889.

dense and fibrous. Generally the tumor is unsymmetrical, extending downward farther on one side than on the other, and its surface may be indented by deep channels.

Histologically the pharyngeal tonsil very closely resembles that of the fauces, being composed of lymphatic or adenoid tissue, made up of a retiform stroma and lymph-cells; the surface is covered with columnar, generally ciliated, epithelium. The whole structure is highly vascular, and follicles similar to those of the faucial tonsil occur.

Symptoms.—In addition to the ordinary clinical history of chronic rhinitis, adenoid vegetations produce a very distinct group of symptoms, which are almost diagnostic in numerous instances. Perhaps the most common symptom for which the child is brought to the surgeon is *noisy respiration*, especially during the night, or when suffering from even the slightest “cold.” This is often so pronounced that the child can be heard breathing in an adjoining room, and may be accompanied by semi-suffocative attacks most annoying to the little patient and its care-takers. In older children constant mouth-breathing may cause a formidable train of results: the lower jaw is dropped, the folds between the nose and the upper lip become obliterated, the inner canthi of the eyes are drawn down, and the face becomes in consequence vacant and stupid. Such children are especially prone to have “night-terrors” and to moan and toss while asleep, and nocturnal cough and croup are both exceedingly frequent. The voice lacks resonance, and there is more or less inability to pronounce *m*, *n*, and *ng*.

Ear-complications, due to extension of the inflammatory conditions or to pressure on the Eustachian orifice by masses of adenoid tissue, are often met with. Deafness, tinnitus aurium, and otorrhœa are the usual forms of ear-disease seen; the consequent impairment of hearing is one of the direct causes of the apparent stupidity of children thus affected.

The effects on the general nutrition of obstructive enlargement of the pharyngeal tonsil are considered by many authors to be exceedingly deleterious. While this is undoubtedly the case to a certain extent, it is the opinion of the writer that such conditions are more frequently *concomitants*, due to the same systemic dyscrasia, than direct results of the new growth. It is this fact which renders the best-conducted operations of removal total failures, so far as improving the general health or the mental powers is concerned, in many cases.

The *prognosis* of enlargement of the pharyngeal tonsil depends altogether on the amount of obstruction to respiration occasioned by the growth. Quite large masses may persist for an indefinite time without causing any serious results, provided nasal breathing is not embarrassed; but an apparently moderate amount of stenosis frequently causes grave aural and respiratory symptoms. It is a common occurrence to find large masses of pharyngeal adenoid tissue in young adults who complain of no annoying symptoms, and in whom the ears and larynx are normal, respiration not having been

obstructed. Morell Mackenzie has remarked¹ that there is a tendency among laryngologists to exaggerate the importance of these growths, and the writer believes this to be the case to a great extent in this country. There can be no doubt that very large pharyngeal, as well as faucial, tonsils may persist into early middle life without producing a single one of the formidable symptoms commonly ascribed to this condition. On the other hand, obstructive adenoid vegetations are often most prejudicial to the general health, and are always a serious menace to the ears and the lower respiratory tract. The great prevalence of croup, acute bronchitis, and similar catarrhal attacks among children with hypertrophied pharyngeal tonsils is an important argument for their thorough treatment. Very often, however, the catarrhal tendency is not greatly improved by removal of the offending mass, unless other efficient treatment be also adopted. It must never be forgotten that these masses possess an inherent tendency to undergo atrophic changes in early adult life, and that if no serious symptoms have been caused up to that time, the growths are unlikely to give further trouble.

Physical examination in cases of adenoid vegetations may be made in three ways: by posterior rhinoscopy, by the use of the nasal probe, and by digital palpation. The rhinoscopic mirror can be effectively used in at least seventy-five per cent. of the cases applying for treatment, and is by far the most scientific and accurate means of making a diagnosis. The writer has obtained a perfectly satisfactory image in children under four years of age, and "snap views," sufficient for therapeutic accuracy, in still younger subjects. The mirror having been introduced and the choanæ brought into view, the upper portions of the arch will be found to be partially or wholly concealed by the characteristic masses, and vegetations may also be seen on the lateral walls, often pressing upon or covering the Eustachian prominences. If the vegetations are very great in amount, all the normal landmarks are obliterated, and the vault appears filled with a reddish mass, or a narrow slit may represent the space between the adenoid tissue and the superior surface of the soft palate. Any amount of hypertrophy may exist, from small tuberous masses not larger than a large bean to immense nodular tumors blocking up the entire post-nasal space.

The nasal probe, a firm silver rod some nine inches long, with the usual spherical extremity, is certainly a most valuable instrument in dexterous and careful hands. It may be used through the nose, but it is better to introduce it through the mouth after giving an L-shaped curve to its extremity, the bent portion being slipped up behind the palate. The reliability and consequent usefulness of the information thus gained depend altogether on the experience and digital sensitiveness of the surgeon, and it is impossible to give directions of much value. If the probe meets with a more or less spongy mass a very short distance above the level of the hard palate, the

¹ Diseases of the Throat and Nose, vol. ii. p. 491.

hypertrophy is great; but if the end can be freely swept over the post-nasal arch, the existence of vegetations is improbable or their quantity is unimportant.

Digital exploration of the post-nasal space is regarded as a very formidable method of examination by the writer; done with the utmost care, it is still exceedingly alarming and very often acutely painful, and subsequent sore throat, hemorrhage, earache, etc., are very far from rare. There are a certain number of cases, however, of adenoid hypertrophy in young and intractable children in which palpation offers the only certain means of diagnosis. It is hardly necessary to state that the finger must be absolutely aseptic, and must be introduced with the utmost care and gentleness; the writer invariably lubricates his finger with albolene or other bland oil to facilitate its introduction. The child's mouth must be kept open by means of a cork or a fold of napkin between the teeth, otherwise the surgeon may be severely bitten during the struggles of the unfortunate little patient.

To the touch the vegetations are soft and friable, "feeling like a bunch of earth-worms;" separate movable masses may be felt, or a firm projecting mass may be found to occupy the pharyngeal vault. Slight hemorrhage is the rule, owing to the great vascularity of the growths, the finger when withdrawn being usually stained with bloody mucus.

It is hardly necessary to say that the whole upper respiratory tract, as well as the pharyngeal vault, should be carefully examined in all cases of adenoid overgrowth.

Treatment.—The therapeutic management of inflammatory hypertrophy of the pharyngeal tonsil is by most writers summed up in the formula that all adenoid tissue must be bodily and totally removed to secure relief. It is with much diffidence that the writer ventures to differ with these gentlemen, at least as regards the milder cases, and in the climate of Philadelphia. Only a few years ago the removal of faucial tonsils had quite as many distinguished and strenuous advocates, and to allow an enlarged tonsil to remain *in situ* was thought a heinous surgical offence; the custom which now obtains as regards the pharyngeal gland may perhaps fall into the same desuetude. The fact that intelligent parents in large cities, or at least in this city, are beginning to think—from sad experience among their own or their friends' families—that the operation is often injurious and oftener worthless, has great weight with the writer. Leaving the final decision of the matter to a wiser generation of rhinologists, it is the writer's opinion, first, that many cases of adenoid hyperplasia can be effectually controlled without operative or painful treatment; second, that much more moderate forms of technique than are usually described are sufficient in many cases; third, that the operations are distinctly dangerous unless performed with great judgment and manual skill.

The most efficient management of mild grades of enlargement and chronic inflammation in this region consists in thorough routine treatment of the whole naso-laryngeal region by means of well-chosen sprays, pig-

ments, or, when necessary, acids or the galvano-cautery. The adenoid masses will contract and become less irritable and vascular with the rest of the tract, and in early cases will usually cease to give trouble, provided the "cold-taking" tendency can be controlled. The writer is well aware that it is claimed that removal of the growth annuls this tendency in nearly all cases, but he has neither seen this most desirable result, nor can he understand why the removal of a single hyperplastic area should "cure" profound nervous and vascular changes in the whole respiratory tract. In the case of young children, nasal and pharyngeal sprays applied by the physician with care and thoroughness have a very happy effect; the hamamelis and "listerine" formulæ suggested in hypertrophic catarrh are among the most useful, but the prescriptions must be varied to suit the individual case. A good atomizer driven with a pressure of about ten pounds to the square inch is essential, and the spray must be forced through the nares so that it escapes through the mouth or by the opposite nostril. By the exercise of a little tact and firmness many children under three years of age can be persuaded to submit quietly to the treatment; or if matters come to the worst, the little patient can be held by the mother or attendant. The choanæ having been cleared, the lower pharynx is to be similarly treated, the spray being driven by a pressure of about fourteen pounds. Solutions of sodium benzoate (gr. x to fʒj), potassium chlorate (gr. xx to fʒj), or Dobell's recipe are all useful formulæ for the purpose. If the engorgement of the pharyngeal gland is marked, the sprays should be supplemented by lightly brushing the post-nasal region with a forty-grain solution of tannic acid in glycerin by means of a suitably-curved post-nasal applicator. The application is not altogether painless, and requires a considerable degree of manual dexterity; the utmost care should be taken not to bruise or otherwise injure the parts. Should the palate spasmodically grasp the instrument, the latter must not be forcibly removed, but a moment of relaxation must be waited for, when the cotton-carrier can be slipped out without difficulty. The curved post-nasal atomizer serves a very useful purpose in older children or in adults, as by it the pharyngeal vault can be much more efficiently cleansed and medicated than by the straight instrument.

When hyperplastic processes have considerably advanced, solutions of iodine applied on the post-nasal mop are of distinct value; various formulæ have been suggested, but from one to five drachms of the tincture to sufficient glycerin to make one ounce is at least as valuable as more elaborate compounds. The applications may be made from one to three times per week, being preceded by the sprays above suggested.

Decided degrees of hypertrophy seriously impairing the functions of the nose, and which fail to improve under milder treatment, must be reduced by destructive measures. Bosworth prefers the galvano-cautery, and this as well as chromic acid is employed by many operators for the more moderate degrees of obstructive enlargement. The instrument employed must

be a guarded one, and care must be taken not to injure the surrounding parts: the practice of the writer is to burn away only two or three of the more prominent nodules at each sitting, repeating the operation in a week or two if necessary. Little or no pain or reactive inflammation results from this method, cocaine anæsthesia being quite sufficient for its performance; it is not, however, adapted for use in the case of young children. In the latter class of cases the writer much prefers the curette, introducing a straight instrument through the nose when practicable (Meyer's method), or, if the calibre of the nares is too narrow to permit of this, using an L-shaped curette through the mouth. (Fig. 8.) The rhinoscopic mirror may be used to guide the ring in the case of adults, but in children the sense of touch alone must usually be relied upon; the sensations communicated to the hand through the instrument are sufficient in most cases; if absolutely necessary, the finger may be cautiously introduced behind the palate and the curette manipulated under its guidance. General anæsthesia is usually necessary in the latter instance, and the operation becomes a rather complicated and bloody one.

Very large masses of adenoid vegetations, the cases of which are, fortunately, not very common, accompanied by serious symptoms, demand radical operative measures. These comprise the use of the finger-nail, the finger armed with a cutting guard, sharp curettes, and various forms of cutting forceps. Each method has its advocates and each its dangers, and different cases demand different instruments; the choice, therefore, is very much a matter of opinion. General anæsthesia is always required, and the precautions common to any minor operation are essential. The writer regards the procedure as distinctly dangerous, and to be undertaken only by the experienced, or under the immediate direction of an expert; minute descriptions of technique are therefore unnecessary. The patient being anæsthetized, the mouth is gagged, and the post-nasal space explored and cleared under digital guidance, the instrument best suited to the case being employed. The pharyngeal vault may then be washed out with a non-poisonous antiseptic solution, and dusted, if desired, with some antiseptic powder, subcarbonate of bismuth being usually employed by the writer. Hemorrhage is seldom free, but profuse bleeding has occurred, ending fatally in a few instances; it may be checked by the use of tannic acid, or the post-nasal space may require to be plugged. The child must be kept in bed for at least a few days, the nares frequently sprayed with an antiseptic solution, and all the precautions employed by

FIG. 8.

Seiss's post-nasal
curette.

the general surgeon after any operation observed. It will be seen that the procedure is far from a trifling one, and is not to be undertaken as a routine measure, or by surgeons of limited experience.

The final results are satisfactory *to the patient* in just about the same percentage of cases as most other operations; disappointment and suffering, and occasionally total failure to benefit, resulting here, as elsewhere, in spite of glowing reports and extensive lists of successful cases. In the majority of instances, however, the results of properly-performed removal are decidedly satisfactory: nasal respiration is re-established, the noisy breathing and other consequent symptoms disappear, the hearing frequently improves, and the general health is benefited. Such extreme cases of adenoid hypertrophy are certainly decidedly rare, and moderate curetting or the biting or burning off of a few of the most prominent nodules, combined with the use of iodine, *and proper treatment of the whole naso-laryngeal tract*, is sufficient in the great majority of cases.

Very advanced stages of hypertrophic rhinitis are frequently accompanied by atrophic and degenerative changes in the pharyngeal tonsil. The gland shrinks or disappears almost altogether, the size of the pharyngeal vault being correspondingly increased, and the surface of the mucous membrane becomes granular and fibrous. As a consequence there is crust-formation in the post-nasal space, tough scales of secretion adhering to the roof of the cavity beyond the reach of "hawking" or inspiratory efforts, and often causing almost unbearable discomfort to the patient. In other cases a thick muco-pus accumulates in the same region, or slowly trickles down the posterior pharyngeal wall, producing great annoyance.

On inspection, the appearances of advanced (sclerotic) rhinitis are found, together with marked pharyngeal atrophy and chronic laryngitis in most cases. The post-nasal space is abnormally large, its mucous membrane intensely congested and nodular, or sometimes yellowish and marked with areas of fibrous and fatty changes. The general health of such patients is always much below par, and a bad circulation and irritable heart are very usual concomitants.

The prognosis is not favorable, no treatment giving permanent relief, and there being no tissue left for even the most "radical" of nasal surgeons to excise. Great relief can be given, however, by patient, gentle treatment, and if the cases remain permanently under supervision, comfort can be assured. It should be remembered, in operating on all cases of adenoid vegetations, that this condition of atrophy can be and has been repeatedly brought on by the surgeon, and the advice given by certain authorities to remove every particle of the adenoid tissue appears to many minds somewhat unsafe. It does not seem to occur to the gentlemen mentioned that the pharyngeal tonsil is a normal structure, and that in simple hyperplastic enlargement one is not dealing with a malignant neoplasm, but with a simple inflammatory overgrowth.

The therapeutic measures most valuable in atrophic stages are the use

of cleansing and alterative sprays and stimulating pigments, combined with faradism and proper treatment of the nasal chambers. All powders, douches, caustics, scrapings, etc., are abominations, unworthy the scientific rhinologist, as applied to this condition, where intense irritation and tissue-destruction are the processes already at work. The post-nasal atomizer is especially valuable in these cases, and the writer's syringe catheter serves a useful purpose in dislodging crusts and mucus too adherent to be removed by the atomizer. The latter instrument (Fig. 9) is to be introduced through the nose in the same manner as the ordinary Eustachian catheter, but when the posterior pharyngeal wall is reached it is rotated inward and upward towards the vault; being fixed with the left hand, any chosen solution can be injected through the instrument by means of the syringe. The fine jets of fluid remove masses which cannot be dislodged by any *spray*, and the instrument has none of the disagreeable or dangerous features of the ordinary large post-nasal syringe.

Among the most useful formulæ for use in these cases are solutions of iodide of zinc (gr. iij to fʒj), of thymol (gr. iss to fʒj), or of listerine (one to three of water), or Boulton's iodine solution. They must be applied with skilful and thorough technique, at first daily, and towards the end of the from four to fourteen months of treatment once a fortnight; the bi-monthly applications will probably need to be continued permanently to secure comfort. The stimulants to be used as pigments consist, in the practice of the writer, largely of galanga, sanguinaria, and iodine in the form of the tinctures, diluted with glycerin to suit the individual case. They are applied by the post-nasal cotton-carrier, the whole pharyngeal vault being lightly mopped after the use of the sprays. Additional treatment is to be directed to the general inflammatory condition, faradism applied to the turbinated regions being an especially valuable adjunct.

The constitutional treatment of adenoid overgrowth or degeneration of the pharyngeal tonsil, while often important, is in no sense specific, each case being a law unto itself. Fresh air and exercise, tonics, and the removal of any constitutional dyscrasia apply, of course, to all cases; change of climate, especially to high altitudes in the Southwest, often works wonders. Gouty and rheumatic subjects demand special attention and intelligent treatment to secure good results, well-chosen mineral-waters being the most generally useful. Children must lead a free, open-air life as far as possible, and not be sent too early to school if they show tendencies to adenoid overgrowth, but especially in all cases must every effort to control the "catarrhal tendency" be made.

INFLAMMATORY AFFECTIONS OF THE EUSTACHIAN TUBES DUE TO CHRONIC HYPERTROPHIC RHINITIS.

Secondary affections of the Eustachian tubes are of such frequent occurrence in chronic hypertrophic rhinitis as to be considered a constant part of the pathological history of that disease, the conditions met with

being divisible into two broad groups, acute and chronic Eustachian salpingitis.

Acute tubal inflammation is very common in catarrhal subjects from some temporary increase of the existing rhino-pharyngitis, or may even be caused by forcing septic mucous exudates up the tube in efforts to clear the nose by blowing, etc. The condition may exist as an active hyperemia only, or may go on to deep-seated infiltration and serious inflammation; the latter phenomena, however, usually depend upon *specific irritants*, as the rhinitis and sore throat of measles, scarlet fever, and diphtheria.

The pathological processes are those found in inflammation of any mucous membrane; there is swelling of the mucosa and increased secretion, the exudate containing numerous shed ciliated epithelial cells. The mucus may be so thick and adhesive as to project from the pharyngeal orifice of the tube as a bulla, the masses being of jelly-like consistency and often of considerable size. Similar clots may cause complete stenosis of the tube, even in its osseous portion, and may be connected with other masses in the tympanum. The cause of the swelling of the mucous membrane is partly congestion and partly serous infiltration; migrated leucocytes are also present, especially at the pharyngeal extremity. The gland-follicles are engorged and enlarged, giving a granular appearance to the tubal lips.

The *symptoms* of acute Eustachian salpingitis are pain, usually of an indefinite, dull, heavy character, very variously described by the patient; the affected side feels "stopped up," and efforts are made to relieve the sense of tension by swallowing, working the lower jaw, and yawning. Autophony is nearly always complained of, the patient's own voice sounding to him as if it came from a distance or was in some way muffled. Deafness and tinnitus aurium are complained of if the stenosis lasts longer than a few hours; the degree of hearing-impairment is generally slight, and the subjective sounds are usually described as a high-pitched singing. In a certain proportion of cases the characteristic severe *boring* pain of "ear-ache" is experienced, but as a mere sequel of chronic hypertrophic rhinitis this is the exception rather than the rule.

Examination with the rhinoscopic mirror shows engorgement, sometimes closure, of the Eustachian opening, with very decided redness of the tubal prominence; in the later stages of severe cases the mucous exudate above described is often present. The nasal membrane shows more or less acute congestion in addition to the usual appearances of hypertrophic catarrh, with more or less occlusion by swelling, which rapidly disappears under applications of a five-per-cent. solution of cocaine. The pharynx exhibits marked engorgement of the tonsillar regions in most cases.

The prognosis of acute salpingitis is complete return to normality under proper treatment; but if the disease is permitted to run its course, recurrent attacks are almost certain to ensue, and some permanent impairment of hearing results.

The proper therapeutic management of acute Eustachian catarrh includes

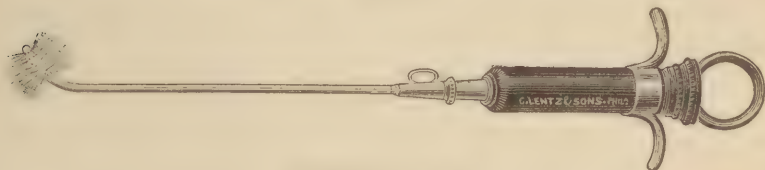
the treatment of the attack and the prevention of recurrences of the disease. The acute or subacute coryza present is first to be controlled by applications of cocaine muriate, about three drops of a five-per-cent. solution being instilled into one or both nostrils. A free breathing-space being secured, the nasal and pharyngeal regions should be sprayed with some delicate antiseptic and sedative formula; and finally a solution, of which the recipe is appended, may be applied:

R Menthol, gr. iij;
Camphor, gr. iv;
Albolene (fluid), f ʒj.—M.

Sig.—Use in atomizer every few hours, if necessary.

In severe cases, where discomfort is great, atropine and sodium bromide given by the mouth seem to exert a strong controlling influence on the disease. Symptoms referable to the middle ear, unless pain is a prominent feature, are far less important, as they will disappear as soon as the salpingitis is controlled, and all meddlesome surgery directed to the drum-membrane through the auditory canal belongs, in the writer's opinion, to the dark ages of otology. Politzer's or catheter inflation may be called for in

FIG. 9.



Seiss's syringe catheter.

the later stages of the disease, and direct tubal applications by means of the writer's *syringe* catheter are indicated should hyperæmia and hypersecretion persist in spite of milder measures. The latter instrument (Fig. 9) has a very distinct field of usefulness in aural therapeutics. It consists of an ordinary silver Eustachian catheter, but is closed at the tip, and the sides of the curved portion are perforated by numerous minute holes. The instrument is provided with an accompanying syringe of two drachms' capacity, which fits the catheter on the ground-joint principle. In use the canula is introduced in exactly the same manner as the ordinary form of Eustachian catheter; being fixed in the tubal opening, the syringe, previously filled with the chosen solution, is fitted into the socket of the catheter and the fluid forced through its perforated extremity. By this means the portion of the Eustachian canal most diseased is thoroughly cleansed and medicated without danger of any of the fluid entering the middle ear; the dangers of such an accident being now generally admitted. Solutions of boric acid (gr. v to x to f ʒj) in rose-water are much used through the syringe catheter in cases of acute salpingitis; dilutions of the white distillate of hamamelis are sometimes substituted in the later stages.

The post-nasal atomizer is also a very useful apparatus in the treatment of tubal inflammation; in skilful hands it can be pointed directly into the tubal openings, and the trumpet-shaped extremity completely cleared of mucus and cellular débris. This instrument, however, cannot be used with all patients, and very seldom with children, and the utmost care should be taken not to strike the tubal prominences or bruise the palate or pharyngeal walls.

The duration of treatment in these cases varies from a few days to three or more weeks, but the patient can usually be dismissed cured within the month. It is of course taken for granted that proper therapeutics have been directed to the general condition of the tympanum, nose, and pharynx.

The prevention of recurrent attacks is to be accomplished by proper hygienic management, the patient being instructed how to avoid as far as possible taking cold, and by improving the general health and vaso-motor tone by exercise, tonics, faradism, etc. Locally the chronic rhinitis is to be controlled by appropriate measures, and the tubes occasionally treated as directed for acute attacks. Patients who are subject to acute salpingitis invariably require careful supervision, and the risks to hearing of neglect or mismanagement of such cases are very great.

Chronic Eustachian salpingitis is the most common aural complication of hypertrophic catarrh, and is the most frequent ear-disease occurring in the Eastern United States, a large proportion of the patients applying for treatment being sufferers from some stage of this affection.

The pathological lesions consist in persistent hyperæmia and cellular infiltration, with enlargement of the glands and thickening of the sub-mucous connective tissue from fibro-blastic organization of leucocytes. This may be so extensive that the hypertrophied mucous membrane is thrown into folds and wrinkles at the Eustachian orifice,—a most important fact to remember when using the aural catheter in these cases. Swelling is marked, and is usually greatest at the ostium pharyngeum, which, according to Schwartz, may be “changed to a mere slit; higher up the tube it is more rare, and is least common in the osseous tube.” In the later sclerotic stages of hypertrophic rhinitis enlargement or widening of the Eustachian canal results from cirrhotic changes, the calibre being occasionally four times its normal lumen.¹

The symptoms of chronic salpingitis are progressive deafness, distressing tinnitus aurium, occasional autophony when the tubes contain mucus, and, under the same conditions, squashing and bubbling sounds in the ear. The symptoms of the acute type are also present in greater or less degree, vertigo, headache, and neuralgia are frequent, and phenomena caused by the nasopharyngitis are prominent in the general clinical history. Although not noted in the text-books, dull pain, throbbing, and a sense of tension and

¹ Schwartz, *Pathology and Anatomy of the Ear*, p. 139.

distention in the ear are among the first and commonest symptoms of this disease.

By posterior rhinoscopy the tubal prominences are found to be swollen, dark red in color, and the openings are often occluded by tenacious mucus or hypertrophied mucous membrane. Large, distended veins similar to those so frequently seen on the pharyngeal wall and epiglottis in long-standing pharyngo-laryngitis traverse the tubal lip, and often appear to run up the canal. Their pathological import is the same as when found in the familiar situations above mentioned. In cases of true naso-tubal sclerosis the Eustachian prominences are atrophied, shrunk, yellowish-gray in color, their openings are plainly visible, and the use of the aural catheter demonstrates the tube to be too freely open throughout its length. The naso-pharynx in these cases shows advanced cirrhotic changes, and deep-seated lesions in the laryngo-bronchial membrane are frequent.

The prognosis of simple chronic Eustachian inflammation, under careful management, is excellent; great relief, occasionally so permanent as to be considered a cure, resulting. In true tubal sclerosis, however, the outlook is very unfavorable; without treatment or climatic change, total loss of hearing seems the only alternative; and misdirected therapeutics, and especially meddlesome operative surgery, assure speedy and hopeless deafness. But fortunately, by the use of proper means, if the patient can be controlled, the disease can be arrested in most cases, and in some instances a slight degree of improvement secured. Even with the conditions obtaining in a large dispensary, it is unusual not to secure a measurable degree of symptomatic improvement, even in very chronic cases, when they occur in vigorous subjects and before later middle life. The most unfavorable conditions are the existence of an hereditary tendency to catarrhal deafness, comparative suddenness of onset of the *chronic* condition, and the *absence* of remediable lesions in the naso-pharynx.

Treatment.—By far the most important indication in chronic Eustachian catarrh is to bring the naso-laryngeal tract as near a condition of normality as its lesions and the state of our knowledge permit. Especially must all obstructions to nasal respiration be removed, the danger of stenosis having been incontrovertibly proved by Pomeroy¹ and others. But although physiologically free respiration through both nostrils is essential to permanent improvement, the utmost conservatism must be practised in using operative procedures, lest inflammatory processes be set up which may rob the patient of even such hearing-power as he possesses.

Therapeutic measures directed to the tube itself consist of insufflations of air and the vapors of menthol, chloroform, iodine, etc.; injections of medicated fluids through the ordinary and the syringe catheter; the use of bougies of whalebone, catgut, etc.; and local faradism. The use of vapors is nearly as old as modern otology, and has been alternately lauded and

¹ Medical Record, February 18, 1888.

condemned by different authors; the writer believes that the applications as generally used very rarely reach the upper portions of the Eustachian tube, and thinks it a fortunate thing for the patients that they do not. Iodine vapor is probably the safest, and possibly the most useful, and may be employed in hopelessly chronic cases as a decided stimulant; it may be used with the attachment for the Politzer air-bag sold by instrument-makers for the purpose. Chloroform, unless used in the smallest dose, obtained by simply charging the air-bag with vapor by allowing it to fill with the tube held over some of the anæsthetic in a wide-mouthed bottle, is regarded by the writer as useless and unsafe. Ordinary inflation methods with simple air belong to the therapeutics of the middle ear, and will be elsewhere considered. Menthol vapor has been lately used by the writer, with very good results in chosen cases, the apparatus of Dench being employed. It is free from irritating effects, and may be tried in all chronic cases requiring mild stimulation.

The injection of medicated solutions through the Eustachian catheter has been very largely abandoned in this country, and the use of all watery solutions in this way is a measure of very doubtful safety and utility. Mild solutions in a perfectly bland *oil* are, however, very well borne, and certainly reduce congestion and relieve tinnitus in many cases. Fluid *albolene* is the best and least irritating base which has been tried by the writer, to the ounce of which may be added from one-half to one and one-half grains of camphor, menthol, or other unirritating stimulant. To make the application an aural catheter is introduced and fixed, and about one-half drachm of fluid is then forced into the catheter by means of a small syringe ground to fit its expanded extremity; the syringe being removed, the oil is quickly blown farther up the tube by the use of the inflation-bag. This method has been used for the last seven years by the writer without his having, as yet, observed any unsatisfactory results follow its employment. The use of watery solutions to the expanded extremity of the Eustachian tube by means of the *syringe catheter* is, however, perfectly safe and distinctly valuable, as the fluid cannot enter the tympanum or reach high up in the canal. It may be employed in the same manner as directed for acute salpingitis, more stimulating solutions, such as the sulpho-carbolate of zinc, being employed. None of the more stimulating forms of treatment should be used oftener than once a week, the therapeutic measures at the one or two additional weekly sêances being limited to applications to the naso-larynx.

The employment of dilating bougies in the treatment of Eustachian stenosis has had some distinguished advocates, but as many severe critics. No writer has doubted that their use is dangerous in any but the most highly trained and cautious hands. Politzer says "their application requires the utmost caution, as the mucous membrane may easily be injured and a submucous emphysema result."¹ The writer considers them most per-

¹ Diseases of the Ear, p. 367.

icious instruments except in an exceedingly small class of advanced sclerotic cases, and even in such he has never seen the slightest improvement follow their use. It is even doubtful if true stricture of the Eustachian tube ever occurs. Schwartze states that "not infrequently an angular bend in the course of the tube or a projection of the carotid canal into the osseous tube is mistaken for stenosis, on attempting to pass a bougie. Real strictures, in the sense in which urethral strictures are formed, by thickening and atrophic shortening of the tissues, appear not to occur in the Eustachian tube."¹ Admitting that a certain amount of absorption from pressure may result in a few cases in the thickened tubal mucous membrane from the use of bougies, their use is too dangerous and too refined in its technique to be described in detail here. If undertaken, the most delicate instrument must be employed and the utmost care observed in its introduction; the probe is then allowed to remain in the tube for a few minutes, and reactive inflammation guarded against by the use of sedative sprays. Politzer's or catheter-inflation may be practised immediately after the dilatation *if the operator is absolutely certain that no wounds of the mucous membrane have occurred*; otherwise, serious submucous emphysema may result. In all inflammatory processes the bougie is strongly contra-indicated, being quite certain greatly to aggravate the existing inflammation. The use of *medicated* bougies has been suggested by certain operators, and the writer has been informed that *nitric acid* has been so used in some clinics. While such procedures may be valuable in the inventor's hands, it is quite certain that they are most dangerous and hurtful in the hands of other aurists, and in the case of the acid might readily cause death, and certainly would produce formidable symptoms.

Faradism is a distinctly useful agent in the treatment of advanced Eustachian salpingitis, acting as an "alterative" as in other regions of the body, its main effects being upon the blood-vessels and nerves. The current is applied directly to the tubal prominences, the turbinated bodies, and the pharynx by means of the straight nasal electrode, for from three to five minutes once or twice per week. The current must never be sufficient to cause unpleasant sensations to the patient, and must not be continued longer than can be readily borne.

Internal treatment is of value in Eustachian catarrh in proportion as it influences for good the rhino-laryngitis and the general health; the former conditions and the general constitutional tendencies of the patient will therefore suggest the therapeutic indications. Careful regulation of the life-habits is often essential, and a large share of fresh air and exercise, accurately regulated, must if possible be secured.

The duration of treatment varies from a few weeks to years, and advanced sclerotic cases require permanent supervision. Treatment may at first be carried out two or three times per week; the interval between the

¹ Pathological Anatomy of the Ear, p. 138.

sittings is then gradually increased until only fortnightly visits are required. In all cases the patient should report with each "cold," or other lighting up of the catarrhal process, and receive appropriate treatment. Local therapeutics may here, as elsewhere, be very easily overdone. Careful and attentive study of the individual patient is required. In proportion to the care with which the aurist studies and is influenced in the treatment by the apparently (to some) minor details will be the improvement in the hypertrophic catarrh and the Eustachian salpingitis.

CIRRHOTIC (ATROPHIC) RHINITIS.

BY JOHN NOLAND MACKENZIE, M.D.,

Laryngologist to the Johns Hopkins Hospital; Clinical Professor of Diseases of the Throat and Nose in the University of Maryland; and Surgeon to the Baltimore Eye, Ear, and Throat Charity Hospital, Baltimore, Maryland.

THE form or stage of nasal inflammation treated of in this section is one which for centuries has been the subject of much dispute, which is one of the most difficult of affections to deal with, and which in ancient times excluded its possessor from the privileges of the priesthood, and in more modern days has actually sufficed for divorce. It was doubtless the universal disgust for this disease that inspired Martial to exclaim that he honored a man with a comely nose, but desired nothing to do with the possessor of a polypus: "*Nasutum volo, nolo polyposum.*"¹ It is the affection known under a host of names, such as dysodia, rhinostenose, coryza foetida, fetid catarrh, dry catarrh, stinknose, punaisie,² rhinitis atrophica, rhinitis atrophica foetida, etc.; but the most common of all appellations is perhaps the ancient one *ozæna*, which in Greek signifies a stench. The term *ozæna* is an unfortunate one, for the condition is, properly speaking, not a disease *per se*, but a symptom of a number of pathological states. Thus, it occurs in all ulcerative³ diseases of the nasal mucous membrane, whether from syphilis, cancer, glanders, rhinoliths and other foreign bodies (in which latter case it is almost invariably unilateral), phagedænic and other ulcers, and is the usual accompaniment of caries and necrosis of the intra-nasal bony framework. It also is occasionally present as a symptom or complication of nasal and post-nasal growths, and may be symptomatic of simple or purulent inflammation of the accessory sinuses, and particularly of the antrum of Highmore. It may occur,

¹ Martial, xii. 37. The term "polyposus" signifies here having a polypus, but it was also used by the ancients to designate those who were affected with *ozæna*, or stinking smell from the nostrils; while the appellation "*ozænosus*" was employed, on the other hand, to denote the presence of a polypus. This would seem to indicate a popular confusion of the two affections and the use of *ozænosus* and *polyposus* as convertible terms.

² The term usually applied by the French. It is remarkable that in the Ayur Veda there is an affection described under the name *pinasie*, which is represented as occurring in an acute and chronic form, and which possibly is the disease in question.

³ The ancients used the terms *ozæna* and ulcer of the nostrils as synonymous.

too, as an accidental phenomenon from simple detention and decomposition of secretion in ordinary coryza, particularly in children, from imperfect removal of the secretion; or in adults and children, either from some imperfectly-defined so-called "idiosyncratic" influence or from the presence of some vice of constitution, inherited or acquired. Occasionally a simple inodorous catarrh will become offensive at the menstrual epoch, losing its disagreeable odor during the decline of the ovarian disturbance, while any existing odor is very frequently aggravated at periods corresponding to those of the menstrual flow. Sometimes a condition resembling it is produced by snuff, various foods, and the habitual use of alcohol.

In the present article the condition known as ozæna will not be treated of in its broadest sense, and attention will be solely directed to that period of nasal inflammation which I have termed in my classification *rhinitis cirrhotica*, and which is used to denote a simple atrophic or cirrhotic condition of the mucous membrane of the nasal and accessory cavities, associated or not with corresponding changes in the bony framework, and usually, if not always, the representative of the third or last stage of nasal inflammation (*vide* section on Pathology).

It must not be understood that every case of hypertrophic catarrh, if left to itself, will terminate necessarily in atrophy. The latter process appears earlier in some cases than in others, the rate and time of its occurrence being probably dependent upon peculiarities of constitution, modes of life, and other conditions which influence the rate of progress of simple inflammation in general. In either or any event, it is usually the sequel of a hypertrophic condition—the legacy of a neglected or, what amounts to the same thing, a badly-treated catarrh.

The existence of syphilis or other diathetic conditions (see Pathology) undoubtedly predisposes to the atrophic process, and I am of the opinion that the constant and habitual use of alcohol is a prolific source of the new formation of connective tissue, just as it leads to similar changes in other organs, notably the liver and kidney.

ETIOLOGY.

In order to understand more clearly the etiology of cirrhotic rhinitis it will be necessary first to refer to the classification of the different forms or stages of chronic catarrhal inflammation of the nasal passages and their relation to the pathological processes which accompany them.

The leading anatomical characteristic of chronic nasal inflammation resides in certain changes which the erectile bodies undergo. In the earlier stages of catarrhal inflammation there exists a peculiar excitability of these structures which causes sudden obstruction of one or both nostrils; later on is found a permanent swollen or puffy (dilated) condition of the erectile tissue, due to a subparalytic state of the intercellular walls with consequent dilatation of the erectile spaces. As the disease advances there is a metamorphosis of the intercellular walls into dense fibrous tissue, which in con-

tracting gradually obliterates these spaces and causes, finally, atrophy of the erectile bodies.

These changes in the erectile structures furnish the anatomical ground for the classification which I present for consideration.

CLASSIFICATION OF THE STAGES OF CHRONIC NASAL INFLAMMATION.

- I. *Simple inflammatory (rhinitis simplex)*; divisible into periods of—
 - a. Irritability of erectile tissue.
 - b. Permanent dilatation of erectile tissue.
- II. *Hypertrophic (rhinitis hypertrophica)*; divisible into periods of—
 - a. Dilatation with hypertrophy.
 - b. Complete hypertrophy.
- III. *Atrophic (rhinitis cirrhotica)*; divisible into periods of—
 - a. Commencing atrophy.
 - b. Complete atrophy.

I. *The first or simple inflammatory stage* consists of two periods, the one characterized by *abnormal irritability* of the cavernous tissue, the other by *permanent dilatation* of the same.

a. *Period of Irritability*.—Characterized by increased irritability of the mucous surfaces, expressing itself chiefly in abnormal excitability of the erectile tissue, leading to sudden obstruction of one or both nostrils in the presence of changeable atmospheric conditions, when the individual assumes the recumbent position, as at night, or when under the influence of certain forms of excitement, and in some women at the menstrual period; in fine, when the individual is exposed to any of the exciting causes of erection of the turbinated tissues.

b. *Period of Dilatation or Permanent Puffiness of the Erectile Tissues (Chronic Coryza)*.—As the result of the repeated erection of the cavernous tissues, which occurs in the first stage, a paralytic or subparalytic state of the resilient and contractile elements of the walls of the erectile cells develops, leading to their permanent dilatation, recognizable by the eye as an engorged or *puffy* condition of the turbinated tissues, which may be distinguished from true hypertrophy by its collapsing under the probe, by the readiness with which it can be pressed against the external wall of the nostril, and by its diminution in bulk under various measures which produce reflex contraction, or emptying or depletion of the erectile spaces, such as the sudden application of cold, the use of cocaine, etc.

It is this subparalytic condition of the tissue, represented by the puffy character of the swelling, which is the *connecting link between the simple and hypertrophic stages*.

II. *The second or hypertrophic stage* is divisible into two periods, characterized respectively by *hypertrophy with dilatation*, and by *complete hypertrophy*.

a. *Period of Hypertrophy with Dilatation*.—Characterized by commencing hypertrophy of the intercellular connective-tissue walls of the erectile bodies

with uniform puffiness of the tissue not especially involved in the fibrous process.

b. Period of Complete Hypertrophy.—Characterized by more or less complete conversion of the affected portion of the tissue into a fibrous mass; swelling generally uniform, unyielding. This complete hypertrophy is most commonly met with on the posterior extremity of the inferior turbinated body, while its anterior extremity is generally puffy, dilated, doubtless from *collateral engorgement*.

III. *The third or atrophic stage* is separable into two periods, one of *commencing atrophy* and one of *complete disappearance of the erectile tissue*.

a. Period of Commencing Atrophy.—Characterized by pronounced contraction of the newly-formed fibrous bands, leading to an irregular, nodular condition of the tissue more prominent in the posterior part of the inferior turbinated body and along its inferior border. This uneven appearance of the diseased portion not infrequently assumes the appearance of fibrous or papillomatous excrescences which may become detached, the process of detachment constituting one step in the future and complete atrophy of the tissue. The erectile spaces are inconspicuous, and, in some places, entirely gone.

b. Period of Complete Atrophy (Turbinated Cirrhosis).—Characterized by a rudimentary condition of the turbinated bodies, due to more or less complete disappearance of the erectile tissue.

PATHOLOGY AND PATHOLOGICAL ANATOMY.

The following account of the pathology and pathological anatomy of intra-nasal inflammation is based mainly on an anatomical study of a large number of inflammatory growths removed from different portions of the nasal chambers and at all stages of the catarrhal process.¹

I. The changes found in common catarrhal inflammation of the nasal passages are pathologically separable into three distinct groups corresponding to the three clinical stages of the disease,—viz., the simple inflammatory, the hypertrophic, and the atrophic.

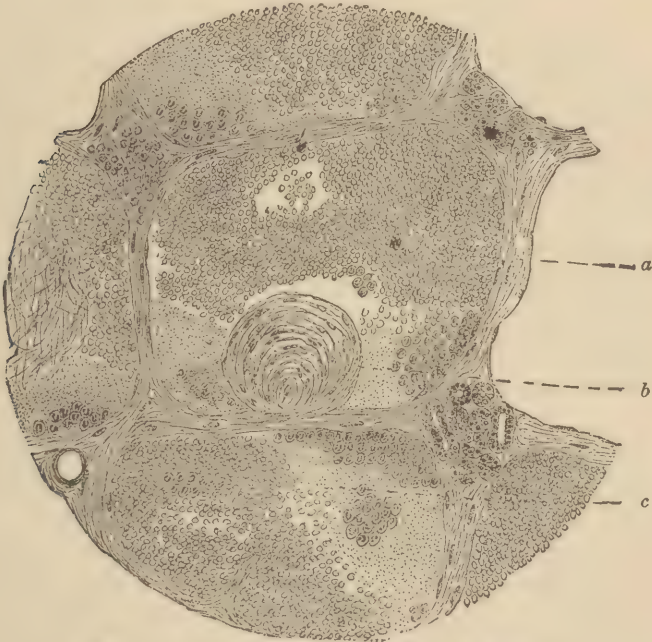
The gross anatomical appearances of the first stage consist essentially in localized or diffuse injection, with moderate swelling of the tissues.

There is very little, if any, swelling of the mucous membrane proper, the main condition being repeated engorgement of the erectile bodies. Portions of the mucous and underlying tissues removed with the snare bleed freely, are soft to the touch, can generally be flattened out with the finger, and, when thrown into alcohol, sink slowly to the bottom of the vessel. They are uniformly smooth in contour, and present, when first removed, a dark purplish and mottled look on the upper surface, while on the under

¹ These observations were first published in the Philadelphia Medical News for October 4, 1884. The drawings which illustrate the text were made from anatomical specimens in the pathological laboratory of the Johns Hopkins Hospital, kindly placed at my disposal by Professor Councilman.

aspect the peculiar spongy appearance of the lacerated and dilated erectile body can be distinctly made out. Under the microscope the appearance which immediately strikes the eye is the enormously dilated and engorged condition of the erectile spaces and the extreme tenuity of their walls. The latter are often reduced to the merest shred, resembling the meshes of a delicate web. Occasionally, large, irregular spaces are observed, which doubtless result from rupture, either before or during the compression produced by the snare. In some cases small hemorrhages are discoverable in the submucous tissue. I have not met with any notable changes in the mucous membrane. The epithelial layer is usually intact, and, beyond perhaps a slight amount of cellular infiltration of the submucous tissues, there

FIG. 1.



Microscopical appearance of the erectile cells in coryza.

is nothing to call for special remark. An excellent idea of the condition of the erectile cells in the first stage may be derived from inspection of the accompanying drawing, in which we have, too, the probable microscopical picture of coryza¹ (Fig. 1). In the case from which the section was taken the nasal passages presented the appearances commonly observed in the condition known as coryza, and in the permanent puffy condition found in more chronic inflammation, the most noticeable being intense engorgement of the

¹ These observations were first brought before the American Laryngological Association in June, 1885, in a paper entitled "A Contribution to the Pathological Histology of Acute and Chronic Coryza." See Transactions, and also New York Medical Journal for August 22, 1885.

cavernous tissue, especially well marked over the lower half of the middle and posterior portion of the inferior turbinated body. Upon cutting into the engorged bodies with a scalpel, the blood, which flowed freely, could be squeezed from them like water from a sponge. The mucous membrane of the maxillary sinuses was not in the slightest degree tumefied, and presented simply a more or less cyanotic appearance.

Under the microscope the condition which at once attracts the eye is the enormous dilatation of the erectile spaces and the extreme tenuity of the intercellular walls. Here and there rupture of the latter had occurred from the enormous blood-pressure, and two or more spaces in this way communicated. Along the inner walls of the dilated spaces were seen congregations of lymphoid corpuscles, and in some of them collections of fibrinous exudation (Fig. 1, *a*, *c*).

The mucous membrane proper presented no noticeable pathological change. The epithelial layer was intact. At some places it seemed slightly thicker than at others, but, beyond a moderate amount of cellular infiltration of the tissues beneath the basement membrane, there was nothing in the mucous layers to call for special remark.

Jutting out from and attached to the wall of the central sinus was a well-formed parietal thrombus, to which I would like to call particular attention (Fig. 1, *b*).

Here, too, is illustrated the minute anatomy of the puffy condition or state of permanent dilatation of the erectile spaces which characterizes the second period of the simple inflammatory stage before hypertrophic changes have developed, and to which I have called attention elsewhere (see Classification).

Of great interest, too, is the formation of the parietal thrombus, as illustrative of a mode of obliteration of the erectile spaces heretofore unrecognized.

In the second or hypertrophic stage the gross appearances vary considerably. The growths, when removed, are either round or oval in contour, uniformly smooth or irregularly lobulated, or covered with little protuberances, giving them the appearance of a raspberry. Frequently, when the loop of the snare is disengaged from the hypertrophied tissue, a small shred or stem projects from the under surface of the latter, which, together with the smooth upper surface of the growth and its rounded, folded-inward edges, presents a striking resemblance to a mushroom. The hypertrophies vary in color, from a dirty-grayish or yellowish-gray to a red and even purplish hue. The color and density of the hypertrophy vary with its age. The older the growth the paler the color and the harder the consistency.

Cross-section with a knife discloses often a peculiar *nutmeg appearance*, due to the interlacing fibrous bands and the dark-brownish aspect of the blood in the erectile spaces. In other cases this nutmeg appearance is not well marked, the whole tissue being converted into a dense fibrous mass. These masses are incompressible, and sink immediately when thrown into

the preserving fluid. They are sometimes covered with little granular or papillary projections.

The microscopical appearances vary. In all, the most remarkable is the conversion of the walls of the erectile spaces into dense fibrous bands, which, in contracting, obliterate more or less completely the erectile cells.¹ These latter present numerous irregularities in outline, and, in those places where the fibrous change is most marked, contain very little, or are altogether destitute of, blood. This fibrous process invades the submucous tissues, and converts them, too, into a fibrous mass in which their glandular elements disappear. The latter are apparently destroyed or obliterated, not only as the mechanical result of the contraction of the new-formed tissue, but also by cellular infiltration of the glandules themselves. The latter is of two kinds, an intra- and a peri-acinal.

When the fibrous process is confined to the deeper layers, the epithelium is usually intact. When, however, the structures immediately under the basement membrane are invaded by the round-cell infiltration, the epithelial layer is notably thickened, often in an irregular manner. This thickening is most marked in the undulations of the free surface. Occasionally the epithelial proliferation assumes the form of distinct filamentous papillary growths, which are beautifully shown under the microscope.

In some places the epithelial cells are filled with a granular detritus, or are altogether wanting. The latter occurs when the fibrous process encroaches on the superficial layers and obliterates their blood-supply. When this occurs, the epithelium may be entirely gone over a considerable extent of surface, nothing being left but the basement membrane. When all the layers are involved in the shrinking of the new-formed tissue, the surface of the growth is often thrown into small, pear-shaped projections or knobs, which consist entirely of fibrous tissue. I am inclined to believe that these knobs may subsequently become detached, and that this process of detachment may be one step in the future atrophy of the membrane. For, if the histories of certain cases of atrophic rhinitis be carefully taken, it will appear that from time to time there are found in the discharge from the nose, during the hypertrophic stage, small nodular masses, which are described by the patients as "little pieces of flesh." They will affirm, furthermore, that when this has occurred the nostrils are perceptibly freer, and, encouraged by this false hope, which they take as an evidence of return to the healthy condition, they neglect treatment and allow the disease to go on to the atrophic stage. I have not met with any mention of this clinical fact in the writings of others, and am inclined to the opinion that the

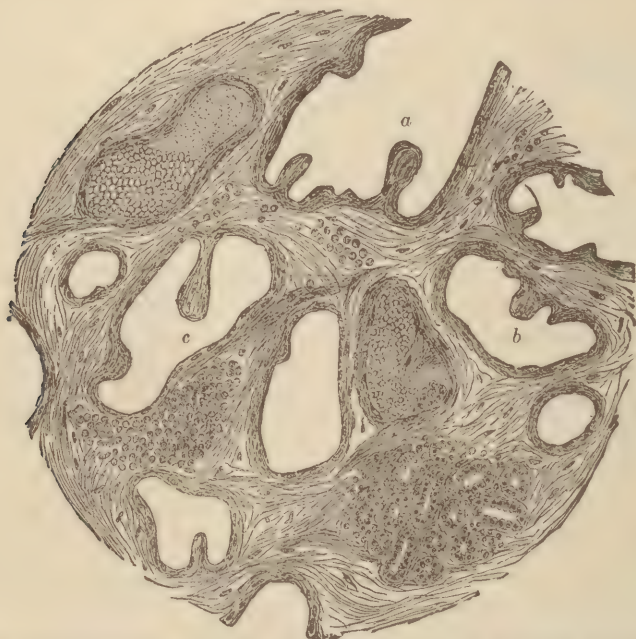
¹ This connective-tissue formation has also been studied by Seiler (*Diseases of the Throat*, Philadelphia, 1883, p. 197) and Bosworth (*New York Medical Record*, June 10, 1882). Seiler found the epithelium intact, although some fatty degeneration of the cells had taken place. In Bosworth's sections the epithelial layer was greatly thickened. The myxomatous change which takes place in the fibrous tissue, and which is mentioned by Seiler, I have also observed.

"pieces of flesh" are none other than these polypoid knobs of fibrous or papillomatous tissue, and that their expulsion may be regarded as an index of approaching tissue-destruction.

Before leaving this brief consideration of the hypertrophic stage, I wish to call attention to an appearance which I have twice met with,—viz., the obliteration of the lumen of the erectile spaces by masses of round cells which resemble the white corpuscular elements of the blood.

I also wish to call attention to certain buds or bulbous processes which in the hypertrophic stage are occasionally found jutting out from the walls of the cavernous sinuses, and which are made up of outgrowths from the newly-formed connective tissue. These appearances were first pointed out

FIG. 2.



Buds or bulbous processes projecting from the walls of the cavernous sinuses.

to me by my friend Professor Councilman, of the Johns Hopkins University, who had taken one of my sections for examination.

Projecting inward, they form bulbous processes or septa of varying thickness, which sometimes interlace, sometimes form bands which connect one portion of the sinus wall with another, thus constituting another factor in the division and obliteration of the cavernous spaces (Fig. 2, *a*, *b*, *c*). Care should be taken not to confound them with the remains of a thinned and ruptured intercellular wall; in the latter case a similar projection will usually be found at a point diametrically opposite to that occupied by the projecting band.

We have, then, four modes of obliteration of the erectile spaces in nasal inflammation :

1. By the contraction of the newly-formed intercellular fibrous bands.
2. By obliteration of their lumen by masses of round cells which resemble the white corpuscular elements of the blood.
3. By the formation of thrombi in certain cases.
4. By the process of septa-formation.

The transition of the first stage into the hypertrophic does not seem to me to depend necessarily upon the presence of constitutional disease, or vice of constitution, inherited or acquired. While it is true that certain diathetic diseases predispose, other things being equal, to the development of this fibrous tissue in excess, the same takes place in the perfectly healthy, and in those who are free from the slightest trace of constitutional taint. In the hypertrophic erectile bodies which I have removed from syphilitic

FIG. 3.



Enormous hypertrophy of the mucous membrane and underlying structures of the septum narium. (Drawn by A. C. Abbott.)

FIG. 4.



The hypertrophic stage of rhinitis chronica.

patients, the fibrous tissue was notably excessively developed, and that this disease predisposes to the subsequent atrophy of the tissue I think there can be no doubt. It is, indeed, doubtless true that certain diathetic conditions, and especially the inherited form of syphilis, as well as certain imperfectly understood personal peculiarities, exert an important influence in the determination of the atrophic stage of rhinitis; but there is a form which, in the present state of our knowledge, is indicative of no particular dyscrasia, traceable to no particular vice of constitution, occurring in the healthy as well as in the badly nourished and cachectic, the clinical and histological history of which contains nothing to differentiate it from the atrophic stage of a simple catarrhal inflammation.

II. Is rhinitis ever *ab initio* atrophic? In the absence of direct histological proof of such an occurrence, in consideration of the rapidity with which in some cases the hypertrophic variety passes into the atrophic, in view of the many obvious difficulties in the way of certain historical data in its favor, and in the light of anatomical investigation, I think that, for the present at least, this question must be answered in the negative. The strongest argument in favor of the independent origin of the atrophic

form is the alleged occurrence of ozæna in the newly-born,—that is to say, atrophic changes show themselves at a period too soon after birth to warrant the assumption of a pre-existing chronic catarrhal inflammation. It seems to me that this objection is sufficiently answered by the by no means violent assumption of the previous existence of an intra-uterine catarrh.¹

That atrophic rhinitis always appears as the sequel of a pre existing catarrhal inflammation is rendered highly probable from a number of clinical and pathological facts. If the clinical history be accurately taken, it will point to a pre-existing catarrhal process. As has been indicated above, the rapidity with which the hypertrophic passes into the atrophic form



Atrophic rhinitis.

of rhinitis is proportionate, in all probability, to the possession of some constitutional taint, such as the congenital or acquired form of syphilis. The early appearance of atrophy in some cases is dependent doubtless, too,

¹ In this way, too, doubtless arise other affections of the nasal passages and throat which are supposed to date their first appearance from or during the birth of the child. To digress still further. It has always appeared to me that the so-called purulent coryza or catarrh of the newly-born, when not the result of gonorrhæal inoculation, may have a similar origin, and does not, as Weber, Fränkel, and others maintain, arise from infection through the leucorrhæal discharge of the mother. While not absolutely denying the possibility of such an occurrence in certain exceptional cases, I am rather inclined to regard it in the same light that I would the time-honored asseveration of the unfortunate who is absolutely certain that he contracted his clap from "a woman with the whites." It is highly improbable that either a simple leucorrhæal or lochial discharge has the power of exciting a purulent inflammation of the nasal passages, and were experiments made to determine this point, they would probably give the negative result which followed Zweifel's experiments on the conjunctiva with the lochial discharge. Moreover, the nostrils of the child are naturally more or less protected by the mucous secretions of the maternal passages, which, in turn, would serve to dilute to a great extent, should such exist, the irritative qualities of the leucorrhæal matter. In the absence, therefore, of gonorrhœa in the mother, it is more probable that the disease originates at some period of intra-uterine life, and not during the transit of the child through the maternal passages. The only argument in favor of Fränkel's view is the obviously insufficient one, that in such cases the existence of leucorrhœa in the mother may be demonstrated.

upon certain modes of life and other conditions which influence the rate of progress in simple nasal inflammation in general. I have seen it also occur with rapidity after the profound impression made upon the nutrition of the parts as the result of acute systemic disease. If the patient be not under intelligent special observation from the outset, it may be difficult to establish with certainty the chronological relationship of the two stages; but so far as my observation goes, I have never been able to satisfy myself of the independent origin of the atrophic form.

In this connection it is worthy to note that the transition of hypertrophy into atrophy does not necessarily imply the existence of ozæna. I now and then see cases in which the most wide-spread atrophy has occurred, and in which the capacity of the nasal chambers is greatly increased, in which no odor can be detected, and I have removed portions of membrane from the nose which showed under the microscope marked atrophic changes, in which no symptoms of ozæna, strictly speaking, were present. How is the fact to be explained that in some cases in which extensive atrophy has occurred there is an absence of the characteristic odor of ozæna, while in others (exclusive, of course, of pre-existing disease of the accessory sinuses) in which the destruction is less extensive there is pronounced fetor? It is insufficient here to urge the operation of *ab extra* influences, or the theory of simple decomposition. Does not the presence of the peculiar odor depend rather upon agencies operating within the organism than upon those which approach from without? In other words, is not the atrophy that results from simple inflammation less liable, other things being equal, to give rise to the characteristic stench than that which depends upon constitutional causes?¹

The pathological history of "ozæna" is, moreover, that of the conversion of hypertrophic changes into those of an atrophic form. In the rhinoscopic image, in the microscopic section, the processes of hypertrophy and atrophy are found side by side. More than that, the atrophic changes are more pronounced in situations in which the catarrhal inflammation originally developed. Thus, for example, if the disease

FIG. 6.



Transition stage from hypertrophic to atrophic rhinitis.

¹ I have shown elsewhere (Congenital Syphilis of the Throat, American Journal of the Medical Sciences, October, 1880) that the deeper naso-pharyngeal lesions of congenital syphilis are found more frequently among females, a fact which may partially explain the common occurrence of ozæna among girls at or near the age of puberty.

originate as a catarrh of the maxillary sinus, the atrophy is more pronounced in the latter situation, the nasal mucous membrane proper presenting evidences of simple or hypertrophic catarrhal inflammation. If, on the other hand, the disease commence in the nasal fossæ, the morbid condition of the sinus, if such exist, is that of simple or hypertrophic inflammation. Finally, as the hypertrophic variety almost invariably commences in the respiratory portion of the nostril, so in the atrophic form the region of the inferior meatus, the classical seat of atrophy, is the first to be destroyed.

Weighty evidence in support of the position that atrophy is always preceded by catarrhal inflammation is furnished by the microscope. Here either the processes are found side by side in the section, or portions of the membrane show signs of atrophy, while in others, where the process is less advanced, hypertrophic changes are discovered.

I have never had the opportunity of a thorough post-mortem examination of a case of ozæna, but I have found the essential changes described by others,—the process of contraction, destruction of glandulæ, etc., in the hypertrophic membrane removed with the snare,—a condition of *turbinated cirrhosis*, so to speak: so that I am forced to regard this atrophy of the membrane, which may with propriety be called *rhinitis cirrhotica*, as the

sequel of a pre-existing hypertrophic condition. At no stage of the catarrhal or atrophic process have I ever met with ulceration.

An opportunity is rarely offered for the histological study of pure uncomplicated atrophy of the nasal mucous membrane. Such chances belong to the accidental discoveries of the post-mortem table, and it is therefore only in a few isolated cases that its pathological histology has been recorded. Among these the most carefully studied are those of Eugen Fränkel¹ and Hermann Krause.²

When the nasal cavities are exposed, they are found filled with a dirty, discolored, foul-smelling mucus and crusts. Upon removing these, the atrophied mucous membrane is seen to be of a pale ashy-gray or dirty-brownish color, its surface either smooth or glazed, or thrown into folds,



Atrophic rhinitis (syphilitic). The characteristic cicatrices are seen on the posterior end of the inferior turbinated bone.

giving it more the appearance of a serous than of a mucous membrane (Zuckermandl). Dense in consistence, it can sometimes be stripped with

¹ Virchow's Archiv, 1879, Bd. lxxv. S. 45.

² Ibid., 1881, Hft. 2 (Separat Abdruck).

ease from the underlying periosteum. Associated with this thinning of the mucous membrane is always more or less corresponding atrophy of the bony framework, and especially of the inferior and middle turbinated bones. Zuckerkandl, who has studied the different phases of atrophy of the turbinated bones in morbid specimens, finds that in the mildest grades of atrophy there is simply thinning, with rupture of continuity, or occasionally perforation of the bone. Later on the free convex edge of the bone becomes straight or even concave, and, as the process goes on, it is reduced to a mere ridge along the wall of the nostril. These changes are more pronounced in the respiratory region, but not infrequently invade the olfactory area.

The histological picture is simply that of a gradual atrophy or wasting away of the different layers of the mucous membrane, and the conversion of their individual elements into fibrous connective tissue, a purely cirrhotic or sclerotic process. The free surface of the mucosa is either completely deprived of its epithelium or covered with cells of varying size and contour—round, polygonal, or spindle-shaped—with cloudy contents and ill-defined nuclei. Here and there it is covered with a fine detritus, which probably represents the remains of the epithelial cells. Fränkel found embedded in a mass of round and spindle cells a number of small oval or rounded nodules, of a transparent, homogeneous appearance, which were found, upon examination with the higher powers of the microscope, to consist of broken-down cells and nuclei, and which were more or less completely isolated from the tissues in their vicinity (as a rule, in the neighborhood of the free surface). Fränkel regards these circumscribed nodules as the representatives of a retrograde metamorphosis of small cells and nuclei,—a process presenting a certain resemblance to the infiltration of cells and nuclei of the subepithelial layer of the vocal cords in certain forms of phthisis.

The subepithelial layers are either crowded with round and spindle cells, represented by a ground substance (stroma) of fibrous tissue, or are converted into a dense structure composed of bands of fibrous connective tissue running parallel with the free surface of the membrane, and enclosing in its substance round and spindle cells, sometimes massed together, the long diameters of the latter being also parallel with the free surface. Here and there, either lying between the meshes of the fibrous tissues or within the substance of the spindle cells themselves (Fränkel), pigment masses are found which consist of an amorphous granular matter, which are more often met with in the upper layers of the membrane, and which disappear as the periosteum is approached. In the cases of Krause, the round and spindle cells either contained a cloudy, granular protoplasm, or had lost their contour and become converted into a fatty detritus. Krause, moreover, found everywhere, interspersed among the different layers, masses of fat-granules, either assuming the form of spindle cells or arranged in rows alongside of each other. In addition to these, which should not be confounded with pigment, groups of fat-globules were discovered, which presented a light

grayish-yellow coloration, and which, together with the fatty degeneration of the cellular infiltration, are regarded by Krause as the cause of the odor in the disease (*vide infra*).

The glands either show no remarkable changes in structure and number, being simply surrounded by a round-cell infiltration in different grades of degeneration, or their lumen may be so encroached on by the newly-formed connective tissue as to cause their complete disappearance. This latter results not only from the compression of the acini, but also from the interference with their vascular supply through the diminution in the calibre of the blood-vessels of the affected area. The changes which bring about this contraction consist in thickening of the adventitia, with corresponding narrowing of the lumen of the vessel.

In Fränkel's case, the lumen of the smaller vessels of the olfactory region, and especially the arteries, was notably diminished or completely obliterated by inflammatory changes in the tunica intima (endarteritis obliterans); while in the respiratory passages these changes in the intima of the smaller vessels were not present.

So far, the microscope has failed to detect any noticeable change in the nerve-elements.

The changes described above are much less pronounced in some places than in others. Here and there the microscopical appearances are rather those of a simple chronic inflammation than of an atrophic condition. These are more marked in the respiratory than in the olfactory region, and may be associated with similar processes in the accessory sinuses. The changes in the latter represent an earlier or a later stage of the inflammatory process, according as the sinuses were originally the starting-points of the disease or were invaded secondarily by the inflammatory process. Thus the mucous membrane of the nasal fossa may be atrophied, while that of the sinuses shows evidences of an acute inflammation or a chronic hyperplastic process.

The changes in the periosteum and bony framework consist essentially in the gradual atrophy of the lacunæ. The walls of the Howship lacunæ are gnawed away in an irregular manner, their lumen is filled with osteoblasts containing a varying number of nuclei, and in some places the space between the individual canals is so narrowed that nothing but a thin remnant of the bone is to be seen (Krause). Division of the nuclei of the bone-corpuscles has been also observed (rarefying osteitis).

It is doubtful whether true ulceration ever occurs as a lesion of simple atrophy. Occasionally abrasions of the mucous membrane are seen which result from accidental causes, such as the use of the finger in the detachment of crusts, or from the separation of the latter when closely adherent to the surface; but neither abrasion nor true ulceration can be, in my experience, included in the pathological picture of the disease.

Against the theory that the atrophic process represents the later stages

of hyperplastic or hypertrophic catarrh, Dr. Bosworth,¹ of New York, basing his view on personal observation, contends that the atrophy is "not due to connective-tissue hypertrophy encroaching on the glandular structures of the membrane, but rather to the transformation of epithelial structures into inflammatory corpuscles, together with an active epithelial desquamation from the surface of the membrane and the lining of the acini." He believes also that the atrophy of the turbinated bones is due to pressure exercised on them "by the drying and contracting of the inspissated mucus," which process he compares to the action of a film of collodion. The latter speculation is scarcely worthy of serious consideration, and in regard to the former, while it is doubtless true that intra- and periacinal glandular infiltrations, as shown above, play a certain rôle in the atrophy of the glandules, there is abundant histological evidence to show that they are not constant or essential factors; while the histological observations of others and myself place the facts of enormous deposit and contraction of newly-formed connective tissue beyond the reach of reasonable controversy.

The horrible stench, which suggested the term *ozæna*, is one of the distinctive objective features of the atrophic stage. It has been compared by the French to the smell of crushed bedbugs, but even this is not sufficiently descriptive. It is penetrating, sickening, diagnostic in itself,—an odor *sui generis*. Its mode of origin has given rise to much discussion and speculation. To account for it, some have assumed the existence of a ferment or micrococcus, either developed in the nasal secretion or derived from the surrounding atmosphere; and that this ferment can be transferred from individual to individual is thought to be probable from the occurrence of *ozæna* in several members of the same family, and its distribution in certain countries, as in Galicia, Poland, and Bessarabia. This hypothesis has, however, been overthrown by the failure to find such a ferment, and by the negative results of direct inoculation with the secretion of the atrophic nasal membrane.

According to others, *ozæna*, or atrophic rhinitis, originates as a chronic purulent inflammation of the accessory sinuses, especially the ethmoidal and sphenoidal, the decomposition of the secretion in these cavities furnishing the explanation of the peculiar odor. This theory, which was originally advanced by Drake,² and was copied by Vieussens³ and Reiniger,⁴ and which has been resurrected in recent days by Michel,⁵ is at variance not only with the clinical but also with the anatomical facts of the case, as

¹ Archives of Laryngology, 1882, vol. ii. p. 236.

² Anthropologia, book 2, chapter x., London, third edition, 1727-28.

³ De natura et necessitate spiritus animalis et de succo nervoso. (In the Bibliotheca Anatomica of Mangetus.)

⁴ Diss. inaugural. de cavitatibus ossium capitis, etc. (In the eighth book of Haller's Dissertations.)

⁵ Die Krankheiten der Nasenhöhle, Berlin, 1876.

demonstrated by post-mortem examinations. There is abundant clinical and anatomical evidence that the sinuses are, as a rule, only secondarily affected, and that a simple purulent inflammation is of itself insufficient to produce the characteristic odor of the disease.

From the stunted or atrophied condition of the turbinated bones, and especially the inferior, which usually accompanies the affection, and the consequent increase in capacity of the nasal chambers, it has been thought by some that congenital atrophy of the turbinated bones, and particularly the inferior, is the essential feature in atrophic catarrh. This speculation, which has been especially insisted upon by Zaufal,¹ rests, however, upon the assumption of facts which in all probability do not exist, for both clinical observation and pathological anatomy demonstrate the fact that atrophy of these structures is invariably secondary,—always the result of pre-existing disease of the turbinated tissues. If congenital atrophy occur at all, it must be reckoned among the rarest of pathological curiosities; for investigations purposely directed with reference to this condition have failed to discover its existence.² There is, moreover, no case on record which may be looked upon as an unequivocal example of congenital atrophy. That abnormal widening of the nasal cavities is of itself insufficient to account for the stench is shown by the fact that the odor is not infrequently altogether absent in cases in which atrophy and destruction of the intra-nasal tissues, resulting in a most widely opened cavity, have taken place. While it is unquestionably true that abnormal widening of the nasal passages favors and predisposes to the development of putrefactive changes within the nose, it is at the same time highly probable that it alone is not enough to account for the peculiar fetor of the disease. To explain the latter it is necessary to assume the existence of some *ab extra* influence, or some alteration in the chemistry of the nasal secretions brought about either by the atrophic changes in the nasal tissues, or from some constitutional or systemic cause. Exactly what such alteration consists in is as yet unknown. Whether it be conditioned by atrophy and disappearance of the glandular elements (Bowman's glands), or by the evolution of fatty acids from the disintegration of fat globules and molecules (Krause), are questions which have received as yet no definite solution. The existence of the former seems hardly sufficient to account for the fetor, while the presence of fat is probably accidental, and has been demonstrated microscopically only in the cases of Krause.

Putrefaction implies the presence of a micro-organism, and hence it is not surprising that the dominant pathology of the present day should inspire a vigorous microscopical search for a possible special microbe. Many

¹ Aertliches Correspondenzblatt für Böhmen, 1874, Nos 23 and 24, 1875, and No. 25, 1867.

² In two hundred and fifty-two skulls of young persons (thirty of whom were in the first months of life) Zuckerkandl found deficiency of the turbinated bones only once, and even in this case they were atrophic from disease.

observers have seized upon the opportunity, prominent among whom may be mentioned Löwenberg¹ and Eugen Fränkel.² The first-named author claims to have discovered a special diplococcus, which he believes to be the essential cause of the disease. But, unfortunately, when the evidence on the subject is thoroughly sifted, there is only one conclusion possible,—viz., that, in the present state of our knowledge, the existence of a characteristic microbe, capable of producing the disease, has not been demonstrated, and that the investigation of the matter has as yet yielded no practical results. The constant exposure of the already fetid and decomposing nasal exudation to every vitiation of the atmosphere is of itself sufficient to render the problem an exceedingly complex one, and it is, therefore, very doubtful whether the discovery of a special microbe for atrophic rhinitis will be an event of the immediate future.

In this country, the changes in the common catarrhal affections of the nose are most marked in the area covered by erectile tissue, and are more pronounced in the lower or respiratory region, in the bony nostril than in the vestibule, and occur in the posterior more frequently than in the anterior portions of the nasal fossæ.

These changes have their starting-point in one or more of three different structures: the erectile tissue, the mucous membrane, and, perhaps, the periosteum. The erectile tissue is primarily involved, probably, in those cases in which catarrhal conditions are met with as the result of reflected irritation (doubtless through vaso-motor influences operating, in the first instance, through the constant or repeated erection of that tissue, with subsequent development of trophic disturbances), and it is conceivable that the same result may be brought about through obstruction or other derangements in the local or systemic circulation; in fine, from any cause that does not act as a direct irritant to the mucous membrane. Even in the latter case the local irritant may, and does in some cases, bring about a similar result through reflex action. A more or less constant dilatation of the erectile cells is thus brought about, which, if kept up, will eventuate, sooner or later, in a paralytic or subparalytic state of the resilient and contractile elements of the intercellular connective-tissue walls.

In another class of cases the process starts from the superficial layers of the mucous membrane, through the irritation produced by foreign substances, the lesions of acute and chronic constitutional or systemic diseases, either through direct infection or through vitiation of the general circulation, and the consequent changes in the nutrition of the mucous membrane. Even in this class there is always more or less secondary erection of the cavernous tissue.

There is still a third class, in which it is probable that the changes in the erectile tissue are secondary to hyperplastic conditions of the peri-

¹ Transactions of the Seventh International Congress.

² Virchow's Archiv, 1882, Bd. lxxxvii. S. 285 *et seq.*

chondrium, as, for example, in the hard, dense hypertrophies met with in syphilitic subjects.

Wherever originating, the erectile bodies become sooner or later involved, and the subsequent changes which they undergo constitute the characteristic feature of acute and chronic nasal inflammation. This is the distinguishing mark between it and other inflammatory conditions of the mucous membrane of the respiratory tract, and it furnishes the rational guide to the management of these affections. I wish to emphasize this fact, for it marks an era in nasal therapeutics. That it is not fully appreciated is evident from the fact that authority often sanctions the use of methods the inevitable tendency of which is to bring about results directly opposite to those they are intended to accomplish.

SYMPTOMS.

In the atrophic or cirrhotic stage of rhinitis, the symptoms of the first and second stages are of course intensified. These have been considered at length in other portions of this work, and it only remains to direct attention to the two most prominent and central phenomena of the cirrhotic process, —the horrible odor and the special tendency to crust-formation. Indeed, the latter may be said to be the characteristic symptom of the disease, for wide-spread atrophy of the intra-nasal tissues may exist without the slightest odor to the discharge.

The crusts vary in color from a dirty brownish-gray or greenish-yellow to a pronounced blackish or coal-black hue. They exhibit also varying degrees of consistency, from soft, easily friable, to tough, leathery masses, and sometimes acquire a stony hardness which may lead to their confusion with dense foreign bodies. Uniform or distinctly laminated in structure, they adhere with great tenacity to the mucous membrane, from which they are separated at intervals varying from two or three days to several weeks, as casts of the regions which they occupy. Occasionally the posterior nares become completely occluded, and the two obstructing crusts become connected by a band over the posterior edge of the vomer, so that when detachment takes place the expectorated crust presents an appearance not unlike that of a pair of eye-glasses.

They occur in all portions of the nose and nasal pharynx, and their expulsion is often attended with great difficulty. They are sometimes detached during sleep, when they may give rise to symptoms of sudden suffocation from their presence at the entrance of the laryngeal vestibule. Their separation is effected by the accumulation beneath them of a fetid muco-purulent secretion. This exudes from the under surface of the crust, and bathes its surface with a thick discharge, in which the hardened mass is partially macerated and expelled, leaving an abraded, bleeding surface at the points of adhesion. The stench is generally intensified during the detachment of the crusts.

This tendency to inspissation of the discharge and the formation of

crusts is, in a great measure, due to abnormal increase in the capacity of the nasal chambers, but it is doubtless also, to some extent, encouraged by the atrophy of the erectile and other sensitive tissues, and the consequent diminution in the reflex excitability of the nasal apparatus.

The amount of discharge varies greatly in different cases. At times it is so profuse that it necessitates the constant use of the handkerchief, while at others it is only trifling in amount. This has led some writers to describe two varieties of the disease, a moist and a dry atrophy.

The destruction of function which atrophy of the intra-nasal structures involves will naturally vary according to the region principally involved by the disease. The senses of smell and taste are usually impaired, or may be entirely destroyed.

Rhinoscopic Appearances.—The external nose is either normal in appearance or presents a variety of unnatural positions. The depressed, flat, and saddle-shaped nose which is characteristic of disappearance of the cartilaginous septum is rarely met with in simple atrophic rhinitis. The changes in the external nose will depend upon the extent to which the destructive process has advanced within the nostril. The abrogation of the respiratory function of the nostrils leads to impairment of the motions of the alæ nasi, and quite often the apex of the nose is tilted upward, so that the anterior nares look more or less directly forward. This elevation of the tip of the nose is also met with in obstruction of the posterior parts of the nostril, and in adenoid growths of the nasal pharynx.

The mucous membrane of the dilated nostril, after the removal of the secretion, is thin and smooth, and of a pale reddish or dirty gray hue. Ulceration is not met with. According to my experience, in simple atrophy the cirrhotic process is most marked in the respiratory region, the lower turbinated bone being, in many instances, reduced to a mere rudiment, allowing in some cases a perfect view of the posterior nasal region. The middle turbinated structures are either atrophied or, as is often the case, simply hypertrophied, and hang in the dilated meatus like polypi. When extensive atrophy exists, the posterior upper wall of the nostril (pars sphenoidalis) can be seen producing the appearance of a more or less lobulated growth. In rare cases the pars nasalis and the upper turbinated bones can be distinctly seen. The changes described above are usually found in both nostrils, but cases are occasionally met with in which the atrophic process is limited to a single nostril, and this apparently independently of pre-existing or concomitant antral disease.

DIAGNOSIS.

The diagnosis of cirrhotic rhinitis is sufficiently easy, and will depend upon the exclusion of the affections causing "ozæna" and on the history of a pre-existing hypertrophic catarrh.

The altogether peculiar odor should be carefully distinguished from that which occurs in the process of bone disintegration from caries and necrosis.

Each is separate and distinct, and the combination of the two baffles all the powers of description.

By alternately closing the patient's nose and mouth the source of the smell may be determined.

It is often difficult for the beginner to detect atrophy in its early stages, and it may therefore not be out of place to point out a few anatomical facts which may serve as aids to the uninitiated. In the natural state the lumen of the nostril, or that space which exists between the turbinated bodies and the septum, is indicated by a slit, narrow and pointed above and broader and more triangular below, which may be roughly compared to the slit in the sounding-board of a violin. When the turbinated tissues are made to contract artificially, obliteration of this slit occurs, the middle and inferior meatuses are represented by a broader, more pyramidal, passage, and the middle and deeper portions of the nostrils come into view. The opening of the posterior nares into the retro-nasal cavity is then seen as a dark, clearly-cut, perpendicular line. In some persons, especially in those whose nasal chambers are naturally capacious, this linear opening may be seen without artificial contraction of the turbinated bodies.

The position of the turbinated bodies also varies within certain limits in the normal condition. When the inferior turbinated bone is "depressed," its anterior end appears as a rounded or, in some instances, bluntly-pointed protuberance jutting out from the external anterior wall of the nostril, and closely in contact with the floor of the inferior meatus, from which it seemingly springs. When the bone is "elevated," there is a distinct, sometimes very broad, space between its inferior border and the nasal floor; the curve and dip of its anterior extremity is generally well defined, so that a *comma-shaped space* is left between it and the external wall. The inferior surface of the bone is not visible except in cases in which the long axis of the bone is directed upward and forward.¹ In some families the inferior turbinated bone of one side is unusually developed without giving rise to serious inconvenience,² a fact which it is well to bear in mind in coming to a conclusion in diagnosis.

The rounded, bulging, middle turbinated bone occupies the upper and outer portion of the anterior rhinoscopic picture. In the anterior portion of the nostril the space between it and the inferior varies greatly within the limits of health. Usually it presents a more or less pear- or inverted-comma-shaped appearance, with or without a comma-shaped space between it and the outer nasal wall.

It is only in very exceptional cases that the superior bone can be seen.

In the posterior rhinoscopic image the floor of the nostril is not visible in health, being hidden by the bulge of the palatal muscles, and the inferior

¹ In a patient suffering from mental disease I observed the inferior turbinated bone so elevated that it occupied the position usually assumed by the middle, and its obliquity was such that more than half of its inferior surface was distinctly visible.

² I have observed this condition twice.

edge of the lower turbinated bone can be seen only in exceptional cases of the "elevated" form. Generally, only the upper portion of its posterior extremity is visible. The posterior border of the septum is almost invariably straight, but just anterior to it, and within the nostril, there is a slight bulging or cushion which represents the cavernous body located there.

The middle turbinated body generally projects inward as a pear-shaped protuberance, while the superior either is scarcely visible or appears as a rudimentary-looking tubercle or projection.

Only a small portion of the inferior meatus is visible as a small, dark, and three-cornered space. That portion of the middle meatus which is included between the turbinated bones is seen in the mirror as either a half-moon or an imperfectly-defined *f*-shaped slit. The irregular spaces between the bones are continuous with the space common to the three meatuses, which appears as a dark chamber in the rhinoscopic image.

The color of the mucous membrane in different individuals, and in the same individual at different periods, varies within the limits of perfect health. It may be said, in general, that it is of a pale reddish hue, more pronounced in the area covered by erectile tissue. In the posterior rhinoscopic picture the color of the membrane appears of a darker hue, the parts being thrown more or less into shadow.

The mucous membrane is closely adherent to the anterior portion of the septum and walls of the vestibule, while over the posterior part of the septum and turbinated bodies it is looser, and separated from the periosteum by the erectile body, which becomes a thin layer as the anterior extremity of the bone is reached.

In the anterior portions of the nostril, therefore, the turbinated bodies are more compact and closely adherent than in the posterior segments of the nasal chamber.

I have dwelt upon the above anatomical considerations because I have found them invaluable guides in diagnosis. In anterior rhinoscopy the amount of swelling may be very conveniently measured by the changes in breadth and direction of the *f*-shaped slit and the degree of obliteration of the comma-shaped space, while the amount of posterior hypertrophy is most accurately determined by the anatomical facts detailed above. The amount of swelling on the septum may also be determined in a similar manner.

The amount of swelling or hypertrophy, and the implication of the bone in the process, may furthermore be measured by the hard and incompressible or the soft yielding character of the masses communicated to the finger through the probe, whilst hypertrophy may be differentiated from mere puffiness by the ease with which the erectile bodies may be emptied or compressed by mechanical causes or artificial contraction. In the latter case the rapidity of contraction is often a measure of the amount of mere puffiness. In using cocaine, for example, if the swelling be due to mere puffiness, acute or transitory engorgement, it subsides very rapidly, almost

instantly, while if hypertrophy coexists the tissues collapse much more slowly and less completely.

In making the diagnosis of incipient rhinitis it should be borne in mind that the disease not infrequently has its starting-point in the erectile bodies, and occasionally in the periosteum. In such cases the first evidence of its existence is a more or less engorged state of the area occupied by cavernous tissue. A stimulus, too, which in the normal state would exert little or no impression is usually sufficient to provoke more or less erection of this tissue, with, it may be, the evolution of reflex phenomena. In all cases the cavernous structure becomes sooner or later involved. Abnormal irritability of the area covered by this tissue, with slight puffiness of the same, is, therefore, an invaluable guide in the early recognition of chronic intra-nasal inflammation. It should be borne in mind, at the same time, that this condition of the erectile bodies is not always the forerunner of rhinitis, but may be due to other and physiological causes. The swelling of the mucous membrane of the vestibule and anterior portion of the septum (cartilaginous septum) is always inconsiderable, except in the latter portion of the hypertrophic stage, when it is often excessive.

In their perfect physiological condition the nasal passages are moistened by a scarcely perceptible halitus, which varies in amount according to the condition of the surrounding atmosphere and other external and internal causes. The existence of mucus must be regarded as pathological, and therefore incompatible with a perfectly healthy condition of the nasal passages. While the secretion of mucus may be due to temporary causes (local or systemic irritation), it is always present in greater or less amount in the earlier stage of rhinitis. The more or less constant presence of mucous secretion within the nostril is therefore indicative of commencing inflammation.

COMPLICATIONS AND SEQUELS.

The possible complications and sequels of chronic nasal inflammation are of the most manifold character, and may be referable to almost every organ of the body. So important is a proper discharge of nasal functions, not only to the structures directly involved, but also to the general welfare of the individual, that the abrogation or suspension of the vital properties of the intra-nasal tissues must be looked upon as one of the most serious obstacles to the enjoyment of normal physiological life. This is especially true in early childhood, when growth and development are going on with great rapidity, and when the demand for healthy respiration is accordingly all the more imperative.

Inflammatory affections of the nasal passages derive much of their importance from their influence on the functions of respiration, olfaction, audition, and voice-production, as the starting-point of diseased conditions of the nasal pharynx and other accessory cavities, and the nasal duct. The affections of these organs to which they give rise are fully discussed in

other portions of this work. The most common is extension of the process to the nasal pharynx. The extension of the inflammatory process into the ethmoid or even the sphenoid cells is also met with, and is often a most difficult sequel to deal with. Lesions of the nasal duct and dacryocystitis are occasional complications; but both these affections and the extension of inflammation to the frontal sinus are comparatively seldom met with, although popular belief would seem to indicate that catarrh of the latter cavity is the prolific source of all the headache of catarrhal rhinitis.

While I am convinced that the chronicity of certain forms of nasal disease, and the persistency of a fair proportion of neuralgic affections and other reflex neuroses of the head and face, are traceable to latent or unsuspected chronic antral inflammation, and while it is doubtless true that affections of the maxillary sinus often run their course unrecognized during life, the *secondary* implication of that cavity in acute and chronic inflammatory processes originating in the nasal passages is, comparatively speaking, rare.

Inflammation of the maxillary sinus may result from congenital or acquired defect of the naso-antral aperture, or from its closure by the swollen and hypertrophied nasal tissue, polypi, crusts, etc., conditions which may favor the retention and decomposition of the antral secretion. Inflammation from this cause, however, occurs less frequently than is universally taught by inference from purely theoretical considerations. I base this assertion not only on clinical observation, but also on the results of post-mortem investigation. Those who choose to investigate the anatomical aspect of this question will be amazed to find how infrequently the mucous covering of the sinus participates in the inflammatory condition of the nasal fosse. It is the rule to find the most marked hypertrophy of the nasal tissues, and even complete atrophy, associated with a normal condition of the sinus. What is the explanation of this fact?

On the nasal aspect of the naso-antral opening is a duplicature of the erectile tissue of the turbinated bodies, which in all probability serves the useful purpose of excluding from the cavity of the sinus, by means of the anatomical barrier involved in its erection, various irritants derived from the external world and nasal passages. This tissue ceases abruptly at the antral aperture. On the other side of the opening lies the peculiar, loose, vascular membrane of the sinus. In the majority of cases this zone of erectile tissue constitutes the extreme anatomical limit of the nasal inflammation. The thin, loose, serous-looking membrane of the sinus differs essentially from the nasal mucous membrane, and especially that portion which surrounds the entrance into the maxillary sinus, and the abrupt transition of the one tissue into the other would therefore militate, on theoretical grounds, against extension of the inflammatory process into the antrum. In other words, I believe that the so-called extension of inflammatory action from the nasal passages to the antrum—the secondary inflammatory implication of that cavity—is of comparatively infrequent

occurrence, and that when inflammation of the sinus from extension is assumed the condition will be found, on post-mortem examination, to be one of simple congestion, with possibly some accumulation and retention of the antral secretion from mechanical causes. Even if the amount of secretion be temporarily increased, the great power of absorption possessed by the membrane of the sinus will usually suffice to make it a matter of secondary importance.

I am inclined to believe that too much stress is laid upon the decomposition of antral secretion as a factor in the production of inflammation. Take, for example, a simple coryza. With the general erection of the turbinated tissues the orifice of the antrum is completely closed; congestion follows, with possibly an increased secretion of the antral fluid. Whether this secretion, thus hermetically sealed, so to speak, in the antrum, undergoes decomposition before the patency of the opening is restored and the air gains admittance, is questionable; but, on the other hand, that decomposition does occur is beyond dispute, for when the swelling from the acute rhinitis subsides the aperture becomes free, and in some instances the fetid antral secretion is discharged into the nasal passages, a fact which accounts for the peculiar fetor of the expired air from the nostrils which is sometimes observed at the close of a severe coryza.

PROGNOSIS.

The prognosis of a disease is one of the most difficult chapters of its history to write. Assertion must be followed by indefinite qualification, and there are so many things to take into account that the study of each case on its individual merits becomes the only rational way to reach an intelligent and satisfactory opinion.

There are two great influences which particularly affect the prognosis in chronic catarrhal diseases of the upper air-tract,—climate and individual environment. Pronounced nasal inflammation of long standing is, in any of its stages, a difficult affection to deal with in a climate in which, to use the language of the *Spectator*, we lie down in July and rise in December. Especially is this true if the individual, either from compulsion or from design, does not live under the guidance of the common laws of health.

The prognosis, in general, will depend in many cases upon the constitution, surroundings, habits, occupation, and a host of other influences pertaining to the individual, and will, accordingly, be determined by an indefinite number of agencies. In this article I shall speak of the prognosis in uncomplicated cases living under fairly good hygienic conditions.

In the early stage of atrophy the prognosis is much less favorable than in the hypertrophic stage, whilst in advanced cirrhosis it is unquestionably bad. Under favorable circumstances it is possible to arrest its progress, and in every case relief can be obtained and the fetor kept under control; but it is naturally impossible to restore the functions of an organ whose physiological properties have been hopelessly destroyed, and the atrophied

structure must therefore be placed, with the contracted liver and kidneys, in the list of incurable affections.¹

When "cure" of atrophic rhinitis is spoken of, it generally refers to a condition of comparative comfort. I have called cirrhotic rhinitis an incurable affection, and yet there are a certain number of cases in which care and time will cause permanent abolition of the odor and restore the individual to perfect comfort and ease.

It may be well to state here that it occasionally happens that extensive atrophy of the nasal structures exists with little or no marked discomfort to the individual. Whether the structures be congenitally absent, whether the condition present is the legacy of a cured syphilitic or other blood affection, or the remains of the destruction left by chrome² or other corrosive chemical agents, are questions sometimes difficult to determine, but the fact remains the same.

Coexisting atrophy of the sinuses makes the prognosis proportionately more grave.

TREATMENT.

The therapeutic history of atrophy of the intra-nasal tissues is a long story,—too long to be told in the contracted limits of the present article. As was mentioned above, the term *ozæna* did not carry with it in ancient times the same significance that attaches to its use at the present day. The Greeks and Romans have left but scanty record of the measures they adopted to cleanse the nasal passages, and indeed, if we consider their notions concerning the pathology of nasal discharges, it would not be surprising if they neglected these important measures altogether. A form of instrument, the *rhinenchytes*, for *injecting* the nasal cavities, is mentioned by Aurelian³ and Scribonius Largus,⁴ but it is highly probable that the important hygienic measure of systematic cleansing and disinfection was neglected. While the ancients apparently did not sufficiently clearly distinguish between "*ozæna*" and "*polypus*," the testimony of their poets, philosophers, and historians would tend to indicate that the agencies productive of the former were more than active amid the culture and refinement of ancient Greece and the debauching influences of the Imperial City.

It is, therefore, not unnatural that the lords and ladies of those days should have resorted to many devices for the purpose of concealing their misfortune; but, as the more certain modes of disinfection were then unknown, we are not surprised when Horace, in satirizing the deception, tells us that he can detect a polypus or fetid smell, no matter how well concealed:

¹ In atrophy of the lower turbinated body it sometimes happens that the middle turbinated body undergoes a corresponding degree of hypertrophy, descends far below its normal level, and seems to functionate in the place of the atrophied body.

² See paper by author read May 8, 1884, before the American Medical Association; see also *Annales des Maladies de l'Oreille et du Larynx*, 1884.

³ *De Chron. Morb.*, lib. ii. cap. 4, lib. iii. cap. 2.

⁴ *De Composit. Medicament.*, comp. vii.

*"Polypus an gravis hirsutis cubet hircus in alis,
Quam canis acer, ubi lateat sus."*¹

The general treatment is tonic and hygienic; the local treatment is palliative, and consists mainly in keeping the parts scrupulously clean and lubricated.

The principal points to be attended to are (1) the utmost cleanliness of the nasal passages, (2) the dissipation of the odor, and (3) the stimulation of the healthy portions of the mucous membrane to vicarious activity.

The methods of cleansing the nasal passages are the nasal douche, irrigation by the anterior and posterior nasal syringe, the nasal bath (pouring the liquid from a spoon, cup, or other receptacle into the nares), direct inspiration of the liquid through the nose (the so-called "drinking" through the nose), or, finally, regurgitation through the nasal pharynx into the posterior nares. When the mucus is very tenacious, the physiological act of sneezing may be provoked in order to assist in its expulsion.

Of these methods the most effective and least objectionable is the spray, except when hot liquids are employed; for in the separation of the liquid into finely-divided spray particles the temperature is so lowered that it practically amounts to a cold injection. For ordinary purposes a fine spray is sufficient, but when the secretion is inspissated or closely adherent a coarse spray is often necessary.

The nasal douche is too dangerous a remedy to be extensively employed, for it often subjects the patient to inflammation of the middle ear. Since Roosa first called attention to this fact, there has been an almost daily accumulation of evidence to warrant the condemnation of its indiscriminate use. Acute inflammation and abscess of the middle ear have repeatedly followed its use, and in one case death was the result.

My experience agrees with that of Beverley Robinson, that chronic inflammatory induration of the turbinated tissues results sometimes from its employment, and I have known cases in which there could be no reasonable doubt that chronic middle-ear disease was caused by its use.

When the nasal pharynx is filled with secretion, gargles are sometimes of benefit, but the sphere of their usefulness is limited. Even by Troeltsch's method very little of the fluid reaches the posterior part of the pharynx, and, as all communication is shut off between the upper and lower pharynx in the act, the remedy never reaches the spot it is designed to medicate. The medicament may act, however, mechanically by producing muscular contraction and thereby dislodging mucus from the naso-pharynx. A gargle of water will accomplish the same result.

Regurgitation of the fluid into the naso-pharynx is an unphysiological procedure, and a roundabout way of accomplishing a great deal of possible harm with considerable difficulty and personal inconvenience. A better

¹ Epode xii. 5.

way is to lie flat on the back, with the head inclined slightly downward, and allow the fluid to gravitate into the pharynx.¹

Whatever method be employed, it should be remembered that the constant use of too much fluid in the nose is often productive of evil, for the reason that it produces a constant saturation of the intra-nasal tissues, with consequent disease and destruction of function. Sprays are not to be employed indiscriminately, nor for too long a period of time. By the spray method water may also gain access to the middle ear, and I have known, in several cases, the use of the post-nasal syringe to give rise to acute inflammation and even abscess of that cavity.

The first indication is best accomplished with a detergent alkaline spray. Carbolic acid, borax, boric acid, the bicarbonate, phosphate, and sulpho-carbolate of sodium, alone or in combination, are the medicaments commonly employed. By means of the compressed-air cylinder, the nasal cavities can be thoroughly cleansed and the crusts removed with facility. If a sufficiently powerful spray be not available, the latter should be carefully brought away, a probe wrapped with absorbent cotton and dipped into vaseline, cosmoline, or some such substance being used for the purpose. Harrison Allen, of Philadelphia, has introduced a novel method of removing crusts from the nostrils. A galvano-cautery electrode is introduced cold into the nasal fossa and made to impinge upon the crust. The current is then turned on. The crust adheres with great tenacity to the heated electrode, and is thus easily removed. Sometimes thick shreds of mucus are found in the Eustachian tubes and the fossæ of Rosenmüller, which cannot be dislodged by the spray, and which must be removed with the cotton-carrier or forceps. This cleansing of the nose is of the utmost importance. It should be ascertained by inspection that the parts are clean before applying alterative or other remedies to the nose. It is useless to apply them to inspissated mucus. The continuous use of alkaline and sulphur waters is sometimes productive of decided benefit in diminishing the secretion.

The astringent or alterative to be used will depend upon the character of the inflammation and upon the susceptibilities of the patient. It is better, as a rule, to change the remedy from time to time until one is found which accomplishes the maximum of good. One of the simplest and best is common alcohol, diluted according to circumstances. Weak solutions of bichloride of mercury are often of decided benefit. For post-nasal and pharyngeal inflammation I have also used the *tincture of galanga* with excellent results. Galanga is an Indian remedy for catarrh, whose powdered root has been recommended (Bosworth) in the form of snuff. It will be found, however, exceedingly difficult to reduce the root to an impalpable powder, and even when mixed with other powders it is irritating and often produces attacks of acute coryza. To obviate this, I have had a very weak

¹ The method of regurgitation of wines and whiskeys into the nasal pharynx employed by wine-tasters is not infrequently the source of post-nasal inflammation.

alcoholic tincture of the root, diluted according to circumstances, prepared for use in spray behind the soft palate. This has an aromatic, not unpleasant odor, and produces a sharp, pungent, peppery sensation, which subsides, however, almost instantaneously, and generally affords immediate relief.

The use of powders in the nose will often do more harm than good, *unless the substance be reduced to an impalpable state*. Their indiscriminate use is to be discouraged, especially where the parts cannot be thoroughly and repeatedly inspected. Otherwise they will form a thick paste with the discharge, whose removal they mechanically impede, or, collecting in the crevices of the nasal chamber, lay the foundation for crust-formation, or act as foreign bodies. It is much better to apply the remedy to the mucous membrane in some such vehicle as glycerin, gelatin, cosmoline, vaseline, etc. This should not be thrust blindly into the nose, but the nostril should be dilated and the application made directly to the diseased surface. Where excoriations or ulcerations of the nostril exist, I have found that the powder of *calendula* dusted over the raw surfaces or applied as a glyceride will cause rapid healing and diminution of the discharge. I have also found the combination of this drug with boric acid, as recommended by Dr. Sexton, of New York, in otorrhœa, of considerable value in purulent cases of catarrh of the nose.

During inclement weather, and when exposed to a vitiated atmosphere, the nasal chambers should be protected by means of a respirator. Those in common use are ungainly objects, against which personal vanity and æstheticism alike rebel. Few patients, especially ladies, will submit to being muzzled with these unsightly appliances, which, besides masking to a great extent their personal charms, are in the eyes of their fellow-man the outward and visible suggestion of chronic nasal catarrh. When the discharge is not very profuse, absorbent cotton, medicated or not according to circumstances, may be substituted for the ordinary respirators. A small piece of cotton is taken and its fibres teased gently apart with the fingers. It is then folded tightly upon itself and introduced into the nostril just beyond the orifice of the anterior nares. If care be taken to separate the fibres sufficiently loosely, respiration can take place with ease. This simple expedient will be found of value to mitigate the severity of the atmosphere and to equalize the temperature within the nasal chambers.

The cotton respirator should not be confounded with the plugs in common use to medicate and give support to the inflamed nasal mucous membrane. The use of tents of various kinds as a means of conveying remedies to the cavities of the nose is of very ancient origin. Long forgotten, this method has in recent years arisen from the dead and has been productive of great comfort to the unfortunate victims of atrophic rhinitis. Thus, Gottstein, of Breslau, recommends the introduction of non-absorbent *cotton tents* into the nostrils by means of a screw in order to act as a mild irritant and prevent the incrustation of the secretion. The plugs, which are made

spindle-shaped to fit the lower meatus, are left in the nostril several hours each day, and in many cases dissipation of the odor is the result.

When the discharge is profuse, or when caries and necrosis coexist with the disease (as in syphilitic subjects), I can strongly recommend oakum as a substitute for the cotton tents commonly employed. Tents may be *medicated* or not, according to circumstance.

The chief objection to the use of tents in the nostril is that in many cases they give rise to too much irritation and the patient is unable to tolerate them. Another method of applying remedies to the nasal passages in this and other affections is by means of *bougies*, generally made with gelatin as a base. These may be substituted for *ointments*, especially when the remedial agent is introduced by the patient himself. Great discrimination should be used in application of oily matter and substances dissolved in glycerin to the nasal mucous membrane. The too long-continued use of oily sprays tends to beget a tendency to unnatural interference with proper secretion, and a dry irritable condition of the mucous membrane is often the legacy of this form of medication. Its continuance for any length of time, therefore, should not be left to the judgment of the patient.

Shurly, of Detroit, and Delavan, of New York, claim good results from the use of the *galvanic current*. The positive pole is placed at the nape of the neck, and the negative upon the nasal mucous membrane. Shurly applies the pole directly, whilst Delavan uses a copper wire wrapped with absorbent cotton. The strength of the current ranges from four to seven milliampères, and the sittings last for from five to twelve minutes, or until the current causes a slight watery discharge.¹ Bernard Fraenkel, of Berlin, applies the electrode of the *galvano-cautery* at various sittings to successive portions of the membrane, so as to cover as much of it as possible with small eschars. This, he asserts, destroys the viscosity of the secretions and aids in the repair of the atrophied tissues.

With a similar end in view, *caustics*, such as chromic and acetic acids, may be cautiously used; and I have sometimes imagined that relief has followed *incision of the atrophied membrane*, by relaxing the tension on the tissues caused by the ever-contracting new-formed connective tissue.

Doubtless *skin-grafting* in atrophic rhinitis may accomplish in the future more than it has done in the past.

In the preceding pages I have endeavored to give a general idea of the principles which should govern the physician in the treatment of this troublesome affection. To enter into detail either in the matter of methods or the comparative merits of drugs would, as I have intimated above, be for me to monopolize the greater portion of this volume. I will therefore content myself, in closing, with describing a plan of procedure which may serve as illustration of the way in which, according to my experience, a case may be satisfactorily treated.

¹ Transactions of the American Laryngological Association, 1887.

The nasal passages should be first thoroughly cleansed and crusts removed by the methods described above. As far as possible, every nook and cranny that might afford lodgement for crusts and drying secretion should be washed out and disinfected. This systematic preliminary cleansing is absolutely essential to the subsequent steps of the treatment, and should be done by the medical attendant until the patient learns how to carry it out himself.

Having gotten the passages perfectly clean, or reasonably so, the next step is the topical application to the mucous membrane of some alterative and astringent. One of the best is the nitrate of silver. The strength of the solution will vary with the sensitiveness of the mucous membrane. I prefer, if tolerated well, a solution containing one drachm of the salt to the ounce of water. Sometimes strong solutions are tolerated better than weak ones, a fact to be explained, doubtless, by their anæsthetic effect, pointed out by Seiler. The medicament is best applied by means of the cotton applicator. This topical treatment should be carried out by the physician, and should be resorted to at first every other day or every third day, the interval between the applications being subsequently lengthened according to his judgment.

At home the patient is directed to make the following routine addition to the morning and evening toilet. In the morning the nostrils must be *thoroughly* cleansed, and the following used afterwards by means of an atomizer :

R Hydrarg. bichlorid., gr. i ;
 Aquæ laurocerasi, f ℥ iij ;
 Aquæ pur., Oss.—M.
 Sig.—For use in spray, in morning.

In the evening, after a second thorough cleansing, the following ointment should be applied and allowed to remain all night within the nasal cavities :

R Hydrarg. oxid. flav., gr. vi-x ;
 Ol. bergami, gtt. vi ;
 Vaseline. vel lanolin., ℥ i.—M.
 Ft. unguentum.
 Sig.—For use at night.

Some people are excessively sensitive to the application of mercury, even in minute quantities, to the interior of the nose and throat. If such susceptibility exist, the above prescriptions will have to be modified according to the circumstances of the case. In cases in which the secretion is very profuse and accumulates rapidly, the nostrils may be cleansed more than twice a day, but once daily is sufficient for the preparations of mercury to be applied. The above does not exclude, on the part of physician and patient, the use of other measures detailed above, but is simply offered as a guide to the rational treatment of the disease under consideration.

The hygiene of the naso-laryngeal tract is coextensive with that of the

general organism, and the hygienic management of this affection must be therefore governed by the laws and principles of health. It is impossible to lay too much stress upon the hygienic treatment of rhinitis, for it is often the key to its successful management. This is a proposition which is frequently on the tongue but seldom in the mind, and the fact is often lost sight of that nothing so militates against the success of local treatment as the improper hygienic surroundings of the patient.

It sometimes happens that, despite judicious local and general treatment, the atrophic process shows little or no disposition to subside; and in this event change of residence offers the surest hope of relief to those whose means and convenience will permit them to move to a more suitable climate.

The general rules governing the selection of a place of residence must be deduced from what is known concerning the geographical distribution of catarrhal affections.¹ Patients generally do better in a moderately high and cold region, where the atmosphere is bracing, equable, and pure, and the temperature and humidity of the air do not vary greatly before and after nightfall. Many mountain resorts are, for example, rendered unfit by the sudden dampness and chilliness which follow the setting of the sun. A very warm climate is often deleterious from the fact that the effect of the heat upon the nervous apparatus often more than counterbalances the good results produced by change of air and scene.

Individuals are variously affected by the air of the ocean. A sea-voyage, or residence by the sea-shore, is in many instances productive of good, and the effects of surf-bathing are often excellent. In some persons, on the other hand, the respiratory mucous membrane seems to resent the presence of salt air; but these are more exceptional.

A patient suffering from any form of catarrhal inflammation of the nasal passages should not be deprived of all the luxuries of life, severed from all legitimate pleasure, or driven to the verge of inquisitorial torture by an enforced system of coddling and a perpetual dread of the changes of the thermometer, nor be taught to rush in-doors whenever a cloud passes over the sun. He should live as much as possible in the open air, and indulge in systematic exercise according to his individual endurance. The skin should be kept in an active and healthy state by daily cold baths, frictions, etc. As little liquid nourishment should be taken as is compatible with the comfort of the individual. The ingestion of large quantities of liquid, especially in the form of alcohol, is greatly to be deprecated. It is surprising what a good effect the combination of exercise and abstention from a superabundance of fluid in the ingesta often has upon the course of a catarrhal inflammation.

¹ For more elaborate discussion of this subject, see paper by the author in the *Transactions of the American Laryngological Association*, 1885; also *New York Medical Journal*, September 12 and 19, 1885.

To sum up, the patient should exercise a sufficient amount of common sense and discretion in matters included under the commonly recognized conception of "taking care of one's self," and should live as far as possible under the guidance of the ordinary rules of health.

Each case must be studied by itself. Indeed, in all cases the search for the cause must be the study of the individual and the complex forces by which he is influenced and surrounded; and upon the correct interpretation of these, more than upon mere inspection of the local malady, will often rest a rational diagnosis and a successful mode of treatment.

LUPUS, TUBERCULOSIS, SYPHILIS, GLANDERS, AND DIPHTHERIA OF THE NARES AND NASO- PHARYNX.

BY GEORGE W. MAJOR, B.A., M.D.,

Lecturer on Laryngology and Rhinology, McGill University; Specialist to the Department for Diseases of the Nose and Throat, Montreal General Hospital; Fellow of the American Laryngological Association, etc., Montreal, Canada.

LUPUS OF THE NOSE.

Definition.—Lupus is defined by Jonathan Hutchinson¹ as a “serpiginous, scar-leaving inflammation of the skin and mucous membranes.”

It is *par excellence* a skin-disease, and selects for its ravages the more exposed parts of the integument. The face is more often the seat of disease than any other portion of the body. The reason for this is the exposure of that part of the frame to cold and weather influences. There are certain regions exempt from lupus, and they are recognized as being centres of the greatest warmth. The form of lupus affecting the nose is the *lupus vulgaris*, and it is almost invariably of the exedens or ulcerating type. The external surface is, as a rule, the first to show signs of morbid action, which may be recognized by the appearance in the corium of an effusion of a brownish-yellow tint, which shows through the cuticle and resembles “apple jelly” more nearly than anything else it could be compared to. This “apple-jelly” appearance is considered by Jonathan Hutchinson to be a most characteristic indication, and to be conclusive evidence in however small quantity it may be present. This stage is usually preceded by some congestion and inflammatory action. Ulceration of course subsequently occurs as the result of the breaking down of the morbid tissues. The nasal mucous membrane is in the majority of instances involved secondarily, and then is the result of infection by continuity.

The skin-lesion is not always found to be in close relation with the disease occupying the nasal chambers, so that in some cases infection must be conveyed in some other way than by extension of surface, most probably by the lymphatic or vascular channels.

The pituitary membrane may be primarily the seat of the disease; this

¹ Harveian Lectures on Lupus, British Medical Journal, January 7, 1888.

is exceptionally so, however. When this occurs the decided tendency is in the direction of extension to the integument. Lupus has been observed to run its course confined to the nasal chambers, when in fact its very existence had not been suspected. It is quite likely that the disease may be more often purely an affection of the mucous membranes than statistical evidence at the present time would admit.

When the mucosa is attacked there is generally a well-marked tuberculous family history obtainable. There is no evidence of the "apple-jelly" appearance referred to when speaking of the skin, but simply a thickened papillary condition of the mucous membrane, which afterwards ulcerates. Luc,¹ of Paris, describes a rare case of lupus of the nasal passages and pharyngo-larynx which occurred independently of any cutaneous lesion. In his case lupus nodules were found on both surfaces of the septum narium. The patient, when seen for the first time, had been a sufferer for six years. Improvement followed the use of iodine and cod-liver oil. A case illustrative of primary and exclusive involvement of the mucous tract has been under the writer's notice for the past two years at his clinic for diseases of the nose and throat at the Montreal General Hospital, and may be considered worthy of record.

J. L., female, aged nineteen years, applied for treatment and complained of a feeling of stuffiness about the nostrils and of a slight discharge. She noticed these symptoms for the first time a month previous to her visit to the hospital. On examination, a perforation of the triangular cartilage was discovered, at the inner circumference of which some ulcerative action was in progress. The appearance of the crusts and the pale-red granulations were quite characteristic of lupus. The perforation, which was of long standing, was of about the diameter of a five-cent piece, or perhaps somewhat smaller. No other ulcerations were visible anywhere in the nasal chambers. On making a laryngoscopic examination, the epiglottis, which was found to have been almost completely destroyed by ulcerative process, was perfectly cicatrized, and there was no evidence of any recent disease elsewhere in the neighborhood. The patient stated positively that she was not aware of ever having suffered from any affection of the nose or throat whatever. She was not conscious of the existence of the perforation, and had not experienced any difficulty or pain in deglutition. The diseased portion of the septum narium was punched out with Sajous' nasal punch, and the wounded surface, which was treated with an ointment composed of ten grains of aristol in an ounce of vaseline, healed kindly. This is an instance of lupus of the mucosa confining itself to that surface, with no tendency to skin-extension, but with a tendency towards recurrence. The specimen was subjected to the examination of an expert, and tubercle-bacilli were found in small numbers. The gross appearances were such as to leave no doubt as to the nature of the case. At the time of writing, the disease

¹ Archives de Laryngologie, 15, ix. 88.

has recurred, and curettement with the application of lactic acid has been adopted.

The young woman is of a tuberculous family. There is no evidence of any lesion of the skin, and the appearance of the patient is that of good general health. This case is one of a few recorded in the literature of medicine, and has been quoted as rather typical of its class. When the skin has been primarily the seat of invasion the disease of the mucous membrane is not likely to escape recognition, but where no lesion of the integument exists the true state of affairs is very easily misunderstood.

Etiology.—The causes that produce lupus are, if not unknown, at least obscure. Raulin,¹ of Bordeaux, regards the single determining cause of lupus to be the penetration of Koch's bacillus into the nasal mucous membrane.

Pathology.—Lupus is now generally regarded as a form of local tuberculosis; an "attenuated tuberculosis" it has been called. It is clearly allied to tuberculosis. It has many pathological features in common with the latter, and is histologically identical. Councilman, in reply to a letter from the writer concerning some points of interest, expressed his conviction as to the identity of lupus and tuberculosis. The grounds given for this belief are briefly as follows:

(a) The histological details of the structural changes in each are the same.

(b) The tubercle-bacillus is found in lupus.

(c) Tuberculosis in the lower animals is produced by inoculating them with lupus-tissue.

Councilman thinks that we are too prone to regard the changes we find in the lungs as the type of tubercular lesions, and holds that the lesions produced by tubercle-bacilli are modified by three conditions,—viz.:

I. The nature of the tissues invaded. Some, as, for example, the skin, are not only more resistant, but their anatomical structure does not favor the advance of lesions.

II. The mode of invasion.

III. Variations in the virulence of the bacilli themselves.

Clarence Rice, in a very able monograph on lupus, explains the differences which are recognized clinically between lupus and tuberculosis as the result of the difference between a chronic and an acute process. He regards lupus as a chronic localized tuberculosis, and tuberculosis as an acute or subacute general tuberculosis. Lupus is a localized deposit, and tuberculosis a general one. However it may be, it is difficult, under any circumstances, to reconcile the differences which are obvious both in gross characters and clinically between lupus and tuberculosis, with their undoubted histological identity.

Symptoms.—The early symptoms of lupus of the nasal mucous mem-

¹ Journal of Laryngology, vol. iv. p. 125.

brane are not of a well-marked nature, and are apt to be overlooked in consequence.¹ When the mucosa is affected, a tubercular family history is often obtainable. There is usually some obstruction to nasal respiration,—a sensation as of a cold in the head of a mild type. There may be itchiness and a moderate amount of sero-mucoid discharge. When a skin-lesion exists, these warnings may lead to an examination, but in the absence thereof, these symptoms are likely to be disregarded. The further course of the disease depends upon the parts involved. The triangular cartilage, or, more correctly speaking, the mucous covering, is usually the first site of lesion. The mucous membrane becomes thickened, then small pale-red granulations or nodules, varying in size from the head of a pin to that of a No. 3 or No. 4 shot, spring up. These soon break down and undergo ulceration. These ulcerations are covered with crusts, which have been described by Kaposi as flat and broad scales of a brown hue, and are considered by him as very characteristic of the disease. These crusts, when disturbed, give rise to but little bleeding, and allow of the escape of a thin watery discharge. The ulceration spreads both in depth and superficially, and perforation of the septum soon follows. The discharge may be of a very offensive odor, but this will depend upon the length of time the crusts have been retained *in situ*, their quantity, and other causes. The alar cartilages may be attacked and suffer more or less destruction. The septal cartilage is, however, the great centre for the intranasal lesion. Ulceration of the anterior borders of the turbinated bodies may also be observed. The amount of nasal obstruction will depend upon the extent of surface involved, the quantity of crusts retained, and the natural conformation and calibre of the passages. Pain is not a prominent symptom, and, if present, is of a modified type. Kaposi asserts that necrosis of bone never occurs in the course of lupus. Jonathan Hutchinson is of the same opinion, and regards involvement of the bone as strong evidence in favor of syphilis. Other authorities, notably the late Sir Morell Mackenzie,² state that the bony structures may be necrosed.

Prognosis.—The prognosis is doubtful so far only as a permanent and radical cure is concerned. After an apparently successful result has been achieved, there still remains a decided tendency to relapse. Bosworth,³ after a critical analysis of the literature of the subject of lupus as an affection of the nasal passages, is of the opinion that the course of the disease is of a decidedly favorable nature, and that but a comparatively few cases resist treatment. He mentions Shurly's⁴ unimproved case, and Rafin's⁵ case, which was cured after eight years' treatment, as of an exceptionally obstinate character.

¹ Jonathan Hutchinson, Harveian Lectures, British Medical Journal, 1888.

² Diseases of the Throat and Nose, vol. ii. p. 405.

³ Diseases of the Nose and Throat, vol. i. p. 380.

⁴ Archives of Laryngology, 1882, vol. iii. p. 307.

⁵ Lyon Médical, 1887, vol. lvi. p. 382.

Shurly, in a private letter to the writer, dated January 18, 1892, states that the patient referred to is now quite well. The late Sir Morell Mackenzie believed that when the cicatrix is indurated, and is of a red color or covered with arborescent vessels, relapses are very probable. The same authority also held that when the disease shows a tendency to pass backward into the pharynx this feature must be regarded as unfavorable. In this latter view most authorities will readily coincide.

Diagnosis.—When disease of the skin coexists, the diagnosis of lupus is very much simplified, and, on the other hand, when no skin-affection is present, there may be, particularly in the early stages of the nasal affection, great difficulty in arriving at a correct conclusion. There are, however, several important points that materially aid in diagnosis.

Lupus is essentially a disease of youth. It progresses slowly towards ulceration, runs a slow course, and spreads slowly. The ulcerations crust over, the crusts are flat and broad and of a brown color. Lupus-granules are red and of the average size of a pin's head or a little larger; though close together, they tend to remain discrete. Under the probe they resist, and if there is actual destruction of surface it is frequently obscured by the granular nodules. There is but scant discharge, which may or may not be offensive. The ulcerations do not tend to bleed. There is but little pain present. The ulceration heals in one direction and spreads in another. The osseous structures are not attacked; the cartilaginous septum almost always is, and perforation is the result, but destruction stops short at its junction with bone. When the floor of the nose is diseased the palate-bones are intact. It is always a creeping superficial ulceration. Jonathan Hutchinson,¹ in his Harveian lectures on lupus, says, "Nothing is lupus which does not spread slowly by infection at its edges, and which does not leave the affected parts more or less disorganized."

In the mucosa it is likely to be mistaken for a syphilitic lesion. The history of the case is of importance in deciding this point. The presence of syphilitic symptoms or scars on the skin, or of cicatricial tissue in the oro-pharynx, particularly if the stellate scar of the pharyngeal wall be observed, will be conclusive evidence in favor of syphilis. Syphilis almost always attacks the bones; lupus, as has been pointed out, avoids osseous tissue. In syphilis there is also infiltration with rapid destruction, and the lupus-granules are not found. If doubt should still exist, a course of antisymphilitic remedies will clear up the doubtful points.

Between it and malignant disease the diagnosis must be made by microscopic investigation, as gross appearances are not to be relied upon.

From nasal tuberculosis it may be known by the characteristic appearance of tubercular ulcers elsewhere. They have a round or irregularly oval shape, uneven base, dirty-gray color, raised, uneven, and undermined edges, and there is usually but one ulcer. Granular tissue may be present,

¹ British Medical Journal, January 14, 1888, p. 59.

but it is covered with a yellowish-looking secretion. The discharge is more of the nature of pus. There is, as a rule, simultaneous pulmonary disease.

Treatment.—The local treatment of lupus of the nasal chambers should consist, first, in removing with great thoroughness all crusts, and the employment of cleansing and disinfecting solutions, before any attempt is made to employ destructive agents.

All affected tissue should be got rid of as soon as discovered. The caustic must be used unsparingly, bearing in mind the fact that any morbid material left behind becomes a centre for fresh infection and new developments. When the septum is the seat of lesion, it may be occasionally necessary to remove the diseased portion by means of Adams's, Steele's, or Sajous' nasal punch-forceps. This is a very radical measure, and if it is not necessary to sacrifice too much tissue it is a good procedure. Volkmann's sharp spoon is preferred by many, and is certainly a very excellent instrument, as all infiltrated parts can be thoroughly disposed of. McBride¹ applies chromic acid after curettement, and speaks highly of its efficiency. Under ordinary circumstances the galvano-cautery is the most elegant means of destruction, and has many advocates.

Paquelin's thermo-cautery may also be used, but it is a much more clumsy means of attaining the same end, and is not more effectual.

The chemical agents most in vogue are chromic acid, lactic acid, nitric acid, and caustic potash. The galvano-cautery and the subsequent use of chromic acid are recommended by Bresgen.²

In the experience of the writer, galvano-cautery is the most convenient and useful means to employ, and lactic acid holds a second place in his estimation.

Shurly³ published two cases of lupus treated successfully by hypodermic injections of iodine. Max Thorner, of Cincinnati, writes privately of the use of pyoktanin. In one case the patient had suffered for twenty years, and had undergone every known process of treatment, including a three months' course of tuberculin at the Marine Hospital, Washington, and a further course of two months at Cincinnati. Under Koch's treatment there seemed at first some improvement. Suddenly the process, that had been at a stand-still, took on again active ulceration, and the destruction of tissue became enormous. When Thorner saw him, half of the nose was eaten away; the infiltration and ulceration extended far into the cheeks and upper lip. The pain was most severe in the infiltrated parts,—an entirely new symptom,—depriving him of sleep. Pyoktanin in a watery solution was rubbed into the parts, introduced into the sinuses, and used also as a powder. A solution of one in two hundred with three-fourths of one per cent. of chloride of sodium was injected into the tissues also. The result at first was magnificent. The pain vanished as if by magic, the

¹ Diseases of the Throat, Nose, and Ear, p. 290.

² Deutsche Medicinische Wochenschrift, 1887.

³ Harper Hospital Bulletin, October, 1891.

ulcerated surfaces became clean and showed healthy granulations, some of the sinuses closed, and cicatrization set in. This, unfortunately, did not last for any time. No sooner had one spot healed than another broke out; when the latter had been covered the former would lose its epithelial coat; and this repeated itself. The treatment was continued for three months with no result. In a second case the result was unsatisfactory. Cresswell Baber¹ speaks highly of the use of resorcin in lupus of the nose.

Trow, of Toronto, reports privately a case of lupus of the alæ, which healed with very little irregularity of surface under the hypodermic use of lactic acid. The injections were made every three or four days. The parts were dressed in the intervals with an ointment composed of salicylic acid and creasote with lard. Black,² of Brighton, recommends scraping and resorcin. Raulin³ has been successful with scraping, as carried out by Moure, of Bordeaux. L. A. Taylor⁴ used liquor sodii ethylatis (made by adding sodium to absolute alcohol) daily for three days, with success. No water must be used during the treatment. Cozzolino⁵ reports five cases treated successfully with the galvano-cautery and careful disinfection of the cavities.

Rafin,⁶ of Lyons, published a case of cure after eight years' duration (where the left nostril was destroyed) by flaxseed-meal poultices and the application of an eighty-per-cent. solution of lactic acid after the method of Mosetig. This case has been already referred to under the head of prognosis.

Gauden⁷ recommends curettement first and dressings of aristol. He holds that, though aristol is useful for cicatrizing purposes, it does not destroy the germs of the disease. Hebra⁸ maintains that his saponated glycerin of creasote and salicylic acid, composed of ninety per cent. of saponated glycerin with five per cent. each of salicylic acid and creasote, is the best anti-bacillar remedy we possess. He states that its effect in lupus is surprising. The saponated glycerin, the basis of the above, is made by warming ninety-five per cent. cocoanut-oil soap with five per cent. chemically pure glycerin. Mackay,⁹ of Brighton, was successful in two cases in two weeks, with an ointment containing twenty per cent. of resorcin, applied after scraping.

Tansini,¹⁰ after the use of many remedies without success, cured two cases after two weeks of treatment, by injecting one-half to one per cent.

¹ British Medical Journal, October 26, 1889.

² Ibid.

³ Journal of Laryngology, vol. iv. p. 125.

⁴ British Medical Journal, October 6, 1888.

⁵ Sajous' Annual, 1888, p. 261.

⁶ Ibid., p. 262.

⁷ Journal des Maladies cutanées et syphilitiques, Paris, July, 1890.

⁸ Zeitschrift für Therapie, Wien, July, 1890.

⁹ Journal of Laryngology, vol. ii. p. 183.

¹⁰ Gazzetta degli Ospitali, and British Medical Journal, June 16, 1888.

solutions of corrosive sublimate. No local and no constitutional disturbance followed. Twelve injections were given in each case.

TUBERCULOSIS OF THE NOSE.

Tuberculosis of the nose is of very rare occurrence. This is somewhat remarkable, considering that it is through the nasal passages tubercle-bacilli first gain access to the human economy. The comparative immunity enjoyed by the nose, doubtless, is owing to the fact that when the bacilli are deposited upon the normal nasal mucous membrane they are washed away by the natural secretion of the part. This should be regarded as a very potent argument in favor of the maintenance of a perfectly healthy state of the nasal mucosa. It is probable that infection in this region occurs only when a breach of surface exists, whereby the bacilli gain access to the tissues and find a suitable soil for further development. The nasal septum near its anterior margin is a common seat of abrasion, and it is for this region that tuberculosis evinces a decided predilection. Hajek¹ is of opinion that the ulcerative lesions in the noses of young children are more often indicative of tubercular processes than has hitherto been admitted.

In the autopsies of four hundred and seventy-six tuberculous bodies, Willigk² found nasal tuberculosis once only. Weichselbaum³ made the observation but twice in one hundred and forty-six post-mortem examinations of tuberculous persons, while E. Fränkel⁴ did not find a single instance of the nasal lesion in the examination of fifty patients who died of tuberculosis. Bosworth,⁵ in his very excellent article on tuberculosis of the nasal passages, discusses at some length the literature of the subject. He refers to the instances published by Laveran,⁶ Riedel,⁷ Spillmann,⁸ Tornwaldt,⁹ Weichselbaum,¹⁰ Milliard,¹¹ Richl,¹² Demme,¹³ Berthold,¹⁴ Sokolowski,¹⁵ Schäffer,¹⁶ Cartaz,¹⁷ Juffinger,¹⁸ Hajek,¹⁹ Kikuzi,²⁰ Luc,²¹ and Tenneson,²²—twenty-

¹ Internationale Klinische Rundschau, January 6, 1889.

² Sir Morell Mackenzie, Diseases of the Throat and Nose, vol. ii. p. 401.

³ Ibid.

⁴ Ibid.

⁵ Diseases of the Nose and Throat, vol. i. chap. xxv.

⁶ L'Union Médicale, 1877, No. 36, p. 501.

⁷ Deutsche Zeitschrift für Chirurgie, Leipsic, 1878, Bd. x. Ss. 56-58.

⁸ As quoted by Cartaz, La France Médicale, 1887, No. 85, p. 1020.

⁹ Deutsches Archiv für Klinische Medizin, Leipsic, 1880, Bd. xxvii. Ss. 586-591.

¹⁰ Ibid., S. 586.

¹¹ Bulletin de la Société Médicale des Hôpitaux, 1881.

¹² Wiener Medicinische Wochenschrift, 1881, No. 4, S. 1261.

¹³ Berliner Klinische Wochenschrift, 1883, No. 15, S. 217.

¹⁴ Ibid., 1884, No. 40, S. 664.

¹⁵ La France Médicale, 1887, Nos. 84-87. (Quoted by Cartaz.)

¹⁶ Deutsche Medicinische Wochenschrift, 1887, Bd. xiii. Ss. 308-310.

¹⁷ La France Médicale, 1887, Nos. 84, 85, 86, 87.

¹⁸ Wiener Klinische Wochenschrift, 1888, No. 36, S. 748.

¹⁹ Ibid.

²⁰ Beiträge zur Klinischen Chirurgie, Tübingen, 1888, Bd. iii., Heft 3, S. 423.

²¹ Archives de Laryngologie, Février, 1889, No. 1, p. 19.

²² Annales de Dermatologie et de Syphilographie, March 25, 1889, p. 214.

seven cases in all, of which Bosworth considers twenty only as of a reliable nature.

In addition to the foregoing, and in order to bring the literature of the subject up to date, there may be added the twenty-three examples of this rare lesion reported by Lennox Browne,¹ J. E. Boylan,² Michaelson,³ Siefert,⁴ Kikuzi,⁵ Grossard,⁶ F. Hahn,⁷ Cresswell Baber,⁸ Biermann,⁹ Price Brown,¹⁰ and Fitzpatrick.¹¹ Of these more recent cases, twenty-two may be regarded as correctly diagnosed. This makes a grand total of forty-two cases published up to date, on which dependence may be placed.

Shurly¹² reported a very interesting case of suspected nasal tuberculosis in a "spider monkey" at the Thirteenth Annual Congress of the American Laryngological Association. Tubercle-bacilli were found in large numbers in the profuse discharge from the nostrils. The treatment consisted in the inhalation of chlorine gas and chloride of sodium water, which was accomplished by placing the animal in the gas cage twice daily for from three to five minutes each time. When actively treated the bacilli would disappear, but when treatment was stopped for a week they could again be found on examination. The treatment was maintained for six or eight months, when death was produced by the administration of chloroform. At the autopsy there was no microscopical evidence of bacilli.

Symptoms.—The affection usually presents itself to our notice as an accompaniment of tuberculosis of some other organ. It commences insidiously, generally as a single ulceration on the septum near the anterior margin, and may spread from this situation to the floor of the nose or to the turbinated bodies. The ulceration does not differ from a tubercular lesion elsewhere, except so far as it is modified by the anatomical and other characteristics of the region occupied. The ulcerated patch is irregularly round or ovoid in contour, the edges are slightly raised and uneven, the base of the ulcer is of a grayish-yellow color and is filled with caseous tubercles. The secretion is mucoid or muco-purulent, slightly sanious, and more or less fetid. There is little or no pain present. These ulcers show no disposition to heal, and, if cicatrization be accomplished, have a very decided tendency to recurrence. Instead of appearing as an ulcerative

¹ Lancet, 1887.

² Cincinnati Lancet Clinic, January 14, 1888.

³ Sixty-Second Congress of German Physicians, September 19, 1889, Journal of Laryngology, vol. iii. p. 480.

⁴ Internationale Klinische Rundschau, Wien, December 22, 1889.

⁵ Satellite, January, 1890.

⁶ Annales de la Polyclinique de Bordeaux, January, 1890.

⁷ Deutsche Medicinische Wochenschrift, Leipzig, June 5, 1890.

⁸ British Medical Journal, June 22, 1889.

⁹ Inaugural Dissertation, Würzburg, 1890. Internationales Centralblatt für Laryngologie, April, 1891, p. 508. One case recorded.

¹⁰ Privately communicated.

¹¹ Cincinnati Lancet, April 18, 1891.

¹² New York Medical Journal, November 7, 1891.

process, nasal tuberculosis may develop as a neoplasm. The tumor, which somewhat resembles a similar development in the larynx, varies in size from that of a millet-seed to that of a hazel-nut or even larger, is of irregular outline and of reddish color, bleeds freely, is soft and friable, and tends to superficial ulceration. These tumors, which are composed of granulation tissue, are very vascular, and under microscopic examination miliary tubercles and Koch's bacilli are found. According to Riedel,¹ giant cells are not found in these tumors. Nasal tuberculosis may invade by extension the muco-cutaneous surface of the nostrils and attack the upper lip. Both the ulcerative form and the neoplastic form may be present in the same individual.

Diagnosis.—The diagnosis is greatly facilitated by the presence of concomitant lesions of the lips, tongue, pharynx, larynx, and lungs.

From lupus it may be distinguished by the absence of lupus-nodules and by the freedom from evidence of lupus of the integument; from syphilis, by the history of the case and the usual naked-eye appearances of syphilitic ulceration. The only true test, however, is a bacteriological examination.

Prognosis.—The prognosis as to cure is unfavorable, as even after repeated destruction the disease will frequently reappear; yet it is the least fatal of all tuberculous lesions.

Treatment.—The treatment should consist of mildly astringent and antiseptic lotions. Local cleanliness is of paramount importance. Insufflations of finely-powdered iodoform or iodol will be found useful, and, if much pain be present, morphine may be added. If the ulcer be of small size, it would be well to punch out the portion of the septum occupied by it and thoroughly to destroy the edges of the wound thus made by applying chromic acid or lactic acid. Curettement and the after-use of lactic acid have been recommended by Olymphis,² Fitzpatrick,³ Boutard,⁴ Cozzolino,⁵ Plicque,⁶ and others.

Cartaz⁷ considers the galvano-caustic method as an excellent means of combating the ulcerative process. Luc,⁸ who has investigated the subject of nasal tuberculosis very thoroughly, is persuaded that the lesion must be treated by surgical measures from its first appearance.

Scheinmann⁹ recommends pyoktanin in nasal tuberculosis.

When the disease takes the form of a tumor it should be removed by the cold-wire snare and its base thoroughly cauterized.

¹ Loc. cit.

² Thèse de Paris, 1890

³ Cincinnati Lancet Clinic, April 18, 1891, p. 468.

⁴ Thèse de Paris, 1889, Revue de Laryngologie, p. 179, March 1, 1890.

⁵ Gazzetta Medica di Roma, Anno xv., 1889.

⁶ Annales des Maladies de l'Oreille, December, 1890.

⁷ La France Médicale, Nos. 84, 85, 86, 87, July, 1887.

⁸ Archives de Laryngologie, No. 1, February, 1889.

⁹ Berliner Klinische Wochenschrift, No. 33, 1890.

The administration of anti-tuberculous remedies should be carefully attended to. Cod-liver oil should be given, having added to it guaiacol in five-minim doses. Guaiacol will be found to be a valuable remedy in any tubercular affection, and may be given in doses gradually increased from one minim to ten minims, three times daily after meals. It may be exhibited in milk or broths, and is quite soluble in glycerin and in sherry wine.

SYPHILIS OF THE NOSE.

Hereditary syphilis is observed in the nose at two distinct periods in the life of the offspring.

The *early* form, which may be regarded as corresponding to the secondary stage of acquired syphilis, develops usually between the second and fifth week, and almost always within the third month, of infant life.

The *later* form may be found at any time between three years of age and puberty, and in female children it most often occurs at the latter epoch.

This *later* form of inherited syphilis is to some extent analogous to the tertiary stage of the acquired disease.

Symptoms of the Early Form of Hereditary Syphilis of the Nose.—The majority of cases, however, occur within the first limit named, and the disease makes its presence known by assuming symptoms characteristic of a coryza. The nasal mucosa is swelled and red-looking, and pours out a quantity of thin watery discharge, which afterwards becomes muco-purulent. This flow irritates the nasal orifices and excoriates the skin of the upper lip. Fissures are produced at the angles of the alæ and elsewhere on the margins of the nostrils. The abnormal secretions tend to dry in the nasal chambers and form crusts. Nasal respiration is interfered with early in the affection, and the noisy breathing known as "*snuffles*" is the result. The nutrition of the infant suffers, as the act of sucking becomes difficult, if not impossible. The disease runs a slow course, shows no disposition to subside, and differs in that important particular from a simple rhinitis. If the nasal chambers are carefully investigated, mucous patches will doubtless be discovered. There is no tendency in this early stage to involve the bones and cartilages, though in a certain proportion of cases this may happen, and the shape of the nose suffer thereby. When the perichondrium and periosteum are affected through the extension of the disease from the mucous membrane, the cartilages and bones take on necrotic action; the discharge also is increased in quantity, becomes purulent and sanious, and develops a most offensive and characteristic odor.

Symptoms of the Later Form of Hereditary Syphilis of the Nose.—When hereditary syphilis develops at a later period, it usually occurs, as has been already pointed out, between the third year of life and puberty. This latter stage, which corresponds with the tertiary stage of direct contamination, is characterized by ulcerations and the destruction of the cartilaginous and bony

framework of the nose. Gummatous infiltration is the rule, and may be observed if the case is seen before breaking down of the tissues has resulted. The cartilaginous and bony septum is the part first to be attacked, and then the turbinated bones. Great deformity is the consequence. The hard palate often undergoes perforation from the breaking down of a gumma on its upper surface. The discharge is purulent, bloody, and, as a matter of course, most offensive.

Diagnosis of the Early Form of Hereditary Syphilis of the Nose.—Hereditary syphilis in the *early* stage of development does not offer any serious obstacles to a correct diagnosis. An obstinate nasal catarrh occurring in an infant should be regarded with suspicion, and should lead to an examination of the entire body for negative or corroborative testimony. If the rhinitis be of a specific nature, the nates and genitals will usually afford additional evidence in the presence of papular eruptions. The nasal secretion soon becomes purulent, sometimes bloody, and always irritating. Mucous patches may be found on the nasal mucosa, and an examination of the throat may demonstrate the existence of an erythema, with, possibly, mucous plaques. When the hair of the scalp is shed shortly after birth, the fact should be viewed with suspicion. The shape of the nose is in itself an important point of diagnosis, when the bridge is observed to be broader and flatter than usual. The appearance of the child is also sometimes pathognomonic. The face is weazened, the features have the expression of those of an old man, and the skin is more or less dry, harsh, and earthy-looking, conditions not found in simple rhinitis.

The presence of a foreign body in the nose might simulate the nasal symptoms of inherited syphilis, but here the obstruction will be confined to one side, the discharge will emanate from a single nostril, and the upper lip will be excoriated on the side of obstruction only. If bone be diseased the odor will be practically the same.

Diagnosis of the Later Form of Hereditary Syphilis of the Nose.—The *later* stage of inherited disease offers more difficulties to correct diagnosis. The age of the patient will probably preclude the possibility of the condition being the result of acquired disease. The disease may be confounded with lupus. The nasal chambers are a favorite site of syphilitic disease, whereas lupus generally attacks the nasal mucous membrane secondarily, spreading from the skin of the face. The course of syphilis in the nose is rapid and very destructive; lupus runs a slow course and does not produce much deformity. Syphilis attacks both bony and cartilaginous tissues, with a very strong predisposition for the former, whereas lupus attacks cartilages only and avoids osseous structures.

Syphilis invades the hard palate very frequently; lupus does not. The odor of the nasal discharges in the late stage of syphilis is horrible, whereas in lupus it is not a marked feature.

The presence of syphilitic eruptions or cicatrices is of diagnostic value, as also would be the evidence of lupus-ulcerations or scars on the integu-

ment. Lupus, moreover, shows a decided tendency to attack subjects pre-disposed to tuberculosis. The trial of a course of anti-syphilitic remedies will help to decide a given case, as affording improvement in syphilis, while lupus would be aggravated thereby.

Treatment of Hereditary Syphilis of the Nose.—The local treatment of the early stage of hereditary syphilis should consist in the use of cleansing and disinfecting lotions. Alkaline solutions are of especial value, as they tend to dissolve the crusts and thus prevent the accumulation of dried secretions. Either of the following combinations will be found useful :

R Sodii bicarb., gr. iii. ;
 Acid. carbolic. (Calvert's No. 1), ℥i ;
 Glycerini opt., ℥i ;
 Aquæ dest. q. s. ad ℥i.—Solve.
 Sig.—Use as a lotion.

or :

R Sodii bicarb., ℥ii ;
 Listerine (Lambert Pharmacal Co.), ℥ii ;
 Aquæ dest. q. s. ad ℥viii.—Solve.

Sig.—Add a teaspoonful to a wineglass of warm water and use as a nasal lotion several times daily.

In using a lotion the infant should be laid across the knees of the nurse, face downward, while an assistant injects the liquid into the nasal chambers. A bulb syringe is best suited to this purpose, such as the "Davol bulb catarrhal syringe No. 52." This instrument is not liable to slip and wound the nostrils, and the amount of pressure requisite can be regulated by the hand of the attendant. If the parts are very much swollen, a few drops of a four-per-cent. solution of cocaine might be instilled to open up the nasal passages before employing the syringe. A solution of boracic acid in warm water is also of use in the early stage, and if it should happen to be swallowed can do no harm. All lotions should be used warm, as their solvent power is increased thereby, and they are thus much less liable to produce shock in a child of tender years.

McBride¹ suggests the use of menthol as a good means of temporarily relieving erectile swelling in these cases.

R Menthol, ten per cent. ;
 Olive oil, ninety per cent.—M.

Apply with a feather or camel's-hair pencil. To prevent the fissures and cracks that are likely to occur at the entrance to the nasal chambers an ointment is often a useful application, as—

R Calomelanos, ℥ii ;
 Ungt. cetacei, ℥i.
 Ft. ungt.

¹ Diseases of the Throat, Nose, and Ear, p. 285.

or :

R Aristol, gr. x ;
 Lanoline,
 Vaseline, aa ʒiv.—M.
 Ft. ungt.

Either of the foregoing ointments is to be applied several times a day with a camel's-hair pencil. When the discharge is very profuse it may be collected on cotton tampons, which should be withdrawn when saturated. If crusts adhere very firmly they may be loosened by exciting the act of sneezing.

The *constitutional treatment* should be thorough in its nature and of sufficient duration. It should be both tonic and specific in character. If the child cannot nurse, it must be spoon-fed, and if that is not possible, it must be fed by the bowel. Good food is an essential of success in the treatment of this condition. Cod-liver oil is often of very great service, with or without the syrup of the iodide of iron. Mercury must be exhibited in the shape of gray powder or calomel, and should be so administered as to prevent undue excitement of the gastro-intestinal canal.

R Hydrarg. cum creta, gr. ii-vi ;
 Sacch. alb., gr. xii.
 Div. in chart. no. xii.

Sig.—One to be given three times a day, or as may be found expedient.

or :

R Calomelanos, gr. ss-i ;
 Sacch. alb., gr. xii.
 Div. in chart. no. xii.
 Sig.—One to be given three times daily.

The preference of many is decidedly in favor of inunction. A dilute preparation of calomel or of blue ointment should be spread over a flannel roller and bound round the child's abdomen. Absorption takes place by the friction induced by the movements of the child. The bandage is removed daily. It is far more satisfactory than the internal administration of mercury, neither gripes nor purges, does not so readily tend to make the gums sore, and is altogether under much better control. Either of the following ointments may be used :

R Ungt. hydrarg., ʒi ;
 Adipis, ʒvii.—M.
 Ft. ungt.

or :

R Calomelanos, ʒi ;
 Adipis ad ʒi.—M.
 Ft. ungt.

The former is the more active and more to be relied upon ; the latter may be used when it is necessary to observe secrecy, as it does not stain the skin nor mark the linen.

In the *later* stage of inherited syphilis the treatment must be more active.

The disease is destructive and requires to be quickly got under the control of remedies. Cleanliness and disinfection of the nasal passages are more urgently called for in order to suppress the offensiveness of the discharges and to render the ulcerated process as aseptic as possible. Iodide of potassium should be given in full doses internally, and when improvement has commenced, inunctions of mercurial ointment should be made on the surface of the body. In fact, the treatment is practically that applicable to the tertiary stage of the acquired disease, to the remarks on which the reader is referred.

Primary Syphilis of the Nose and Naso-Pharynx.—Primary syphilis may occur in the nose and naso-pharynx, but such instances are happily rare. Spencer Watson¹ reported a case of primary sore of the nose in the person of a nurse who had charge of a syphilitic infant. The finger-nail was doubtless the medium of contamination.

Moure,² of Bordeaux, has placed upon record an instance of hard chancre of the right nasal fossa.

Marfan³ has recorded a case of chancre of the septum, the result of inoculation by the finger-nail. Pavloff,⁴ of Moscow, has published two cases of hard chancre of the nostrils of non-venereal origin, occurring in men.

The writer had under treatment at the General Hospital, Montreal, an infant with infecting chancre of the nasal passage. The father, when away from his family, had contracted syphilis, and on his return infected both his wife and child through the medium of mucous patches which were present on his lips and tongue.

When a chancre occurs in the region of the nose it does not differ in any important respect from the primary lesion elsewhere.

Symptoms of the Secondary Stage of Acquired Syphilis of the Nose.—The secondary stage of acquired syphilis usually gives rise to symptoms referable to the nose and naso-pharynx, but as they are not, generally speaking, of a marked character nor of a serious nature, they are liable to be overlooked by the patient or simply disregarded as the result of a simple rhinitis. Predisposition to the attack is likely to be increased by unhealthy conditions existing in the nasal chambers. Scrofulous subjects are notably prone to nasal syphilitic affections. The disease develops usually within the first six months of infection synchronously with the earlier secondary lesions of the mouth, throat, and skin.

Treatment.—The local treatment should consist of perfect cleanliness and the local employment of soothing and antiseptic remedies. Painting the mucous surface with a weak solution of nitrate of silver (five or ten grains to the ounce) will be found useful, as tending to stimulate healthy

¹ Medical Times and Gazette, 1881, vol. i. p. 428.

² Revue Mensuelle de Laryngologie, May 1, 1887.

³ Annales de Dermatologie et de Syphilographie, Paris, June 25, 1890.

⁴ Annual of the Medical Sciences, 1891, vol. iv., D. 7.

action. A five-per-cent. solution of chromic acid is also highly recommended.

Constitutional treatment appropriate to the stage of the disease is of course a necessary adjunct. Inunction with mercurial ointment, if properly carried out, should hold the first place in selecting a line of treatment. When this cannot be undertaken, some one of the many salts of mercury must be administered by the stomach. The writer has for many years used almost exclusively the tannate of mercury for internal administration, and has found it to be an excellent mode of exhibition. It has often proved successful when other salts of mercury have failed to produce decided effects. The tannate is prepared, by precipitation, from a solution of nitrate of mercury to which tannate of sodium has been added. It is stable in the stomach, and does not undergo decomposition until the small intestine is reached. It does not salivate quickly, and is easily assimilated and eliminated. It is usually prescribed in gelatin capsules in one-grain or one-and-a-half-grain doses, three times a day after the meals, as—

R Hydrarg. tan. oxydulat. (Lustgarten), gr. lxxv (Merck);

Conserv. rosarum, q. s.

Ft. mass. et div. in caps. no. l.

Sig.—One after each meal.

If the action of the bowels should be excessive, two or three grains of Dover's powder or an eighth of a grain of opium may be added to each dose of the tannate.

This salt is highly spoken of by C. W. Allen,¹ of New York, in the treatment of syphilis.

Tertiary Form of Acquired Syphilis of the Nose.—The tertiary form of acquired syphilis as affecting the nose is of a most serious and formidable character, involving as it does the entire bony and cartilaginous framework of the nose, with possible extension to other bones of the face and skull. It is of importance that an early diagnosis of the nasal condition should be made, in order to save the patient the frightful disfigurement consequent upon the deep-seated lesions undergoing ulcerative changes. *Gummata* are responsible for the extensive destructive process here set up.

Symptoms.—The infiltration of the mucous membrane gives rise to a local swelling of greater or less extent. Later on ulceration takes place; the ulcer is deep, with ragged edges, and its outline is red and inflammatory. The sense of smell is interfered with. The nasal discharge is increased in quantity. The character of the voice is altered, as the resonance of the nasal chambers is lost. The secretion covering the ulcer is purulent and bloody, has a tendency to desiccate and form a yellowish-green scab, when recent, and later changes to a yellowish-black crust, which adheres with tenacity to the ragged edges of the open surface. The odor is fetid and

¹ New York Medical Record, January 2, 1891.

baffles description. The probe, if used, will likely reveal the presence of diseased bone or cartilage, more or less obscured from view by shreds of necrosed tissue. The cartilaginous septum is usually the first part to be attacked, and depression of the tip of the nose results. The vomer is the part next in order to be invaded, and a flat broad bridge is produced. The turbinated bones may also be involved, and may be detached in portions or *en masse*. The sequestra may be observed as dark greenish-black masses, and present a worm-eaten-looking surface. Under the probe they will impart the peculiar feel of diseased bone as distinguished from that of bare bone. After a time the alæ and tip will sink, become flattened out, and undergo atrophy. These gummatous deposits may occur subcutaneously, as in a case recently under observation. The favorite site here would appear to be over the nasal bones. The odor is characteristic as soon as necrosis of the bone or cartilage begins. It is penetrating, and it is with difficulty that it can be dislodged from the apartment occupied, even for a few minutes, by the unfortunate victim. The entire nose may be destroyed, leaving two gaping apertures to represent the original situation of the organ.

Diagnosis of Tertiary Syphilis of the Nose.—The diagnosis is not difficult. When other indications of syphilis exist it is absolutely certain. From lupus it may be distinguished by the absence of the well-known lupus-tubercles. The palate bones are also frequently necrosed in syphilis, never in lupus. Lupus shows a special predilection for cartilage and a special avoidance of bone. If any doubt should exist, a course of iodide of potassium will soon dispel it. From atrophic rhinitis it may be distinguished by the difference in the character of the odor. Cleansing the passages will considerably diminish the odor of ozæna, whereas the most rigid cleanliness will not reduce the stench given off by diseased bone.

Treatment.—In treating syphilis of the nose and naso-pharynx, local treatment is of importance. Cleansing and antiseptic washes should be used freely by means of a syringe, or, better still, by the post-nasal douche, several times daily. Cleanliness of the diseased region is of the very greatest consequence, as unless the accumulated secretions and blood-crusts are got rid of it would be impossible to carry out, with efficiency, topical applications. Before resorting to the douche, it is well to spray the nasal chambers with warm vaseline; this procedure will be found to facilitate materially the detachment of dried-up secretions. A cleansing solution should be used warm, should combine solvent with deodorizing properties in the highest degree, and should be of an unirritating character. Any of the following formulæ will answer the purpose of cleansing :

R Sodii bicarbonatis,
Sodii boratis, āā ʒi;
Acid. carbolic. (Calvert's No. 1), ʒi;
Aquæ calidæ, ʒxx.—Solve.

A little glycerin (ʒi-ʒiiss) added to the above will make it more soothing.

Or :

R Potass. chloratis, ℥ss ;
 Sodii bicarbonatis,
 Sodii boratis, aa ℥i ;
 Aquæ calidæ, ℥xx.—Solve.

or :

R Sodii salicylatis, gr. x ;
 Sodii boratis, ℥i ;
 Aquæ calidæ, ℥xx.—Solve. (S. Johnson.)

or :

R Hydrogen. peroxid. (Marchand's), fifteen-volume solution, ℥iii ;
 Aquæ calidæ, ℥xvii.—M.

The peroxide of hydrogen solution is not only a valuable means of cleansing the diseased surfaces, but also deodorizes in a very marked degree. After the parts have been thoroughly cleansed with any of the foregoing solutions or any modification of them that may suit the individual case, a stronger detergent may be used with advantage, such as—

R Liq. potass. permanganatis, ℥i-℥iv ;
 Aquæ calidæ ad ℥xx.—M.

or :

R Liq. sodii chlorinat., ℥i-℥ii ;
 Aquæ calidæ ad ℥xx.—M.

or :

R Zinci sulpho-carbolatis, ℥ii ;
 Aquæ calidæ, ℥xx.—Solve.

or :

R Potassii chloratis,
 Ammon. muriatis, aa ℥i ;
 Potassii permanganatis, ℥ss ;
 Aquæ calidæ, ℥xx.

The last formula (after Sajous) combines solvent and stimulating properties with powerful disinfectant qualities.

Blowing the nose will aid in the removal of crusts, or a sponge probang, previously moistened, may be used to free them and allow of the better access of the cleansing solutions. Any accumulated débris which still adheres to the ragged edges of the ulcerations may be removed by suitable forceps. Necrotic tissue should be disposed of by means of the curette, Volkmann's sharp spoon, or other appliance. The application of acid nitrate of mercury or nitric acid is not to be recommended, as the tendency would be in the direction of further destruction of tissue. Any loose sequestra of bone should be removed from the nose as soon as possible ; no violence should be used, however, in the act of extraction. So long as diseased bone is present it will act as a foreign body and the stench will be continued.

Goodwillie's method of removal by revolving knives and burrs may be used with success in selected cases. Great skill is required in the use of

such appliances in these cases of advanced disease. There is no doubt that removal of diseased bone will not only prevent further extension of the disease, but will also shorten the duration of the period of offensiveness. The insufflation of iodoform, or iodoform and finely-powdered camphor, is often used to keep down the odor and at the same time render the parts aseptic.

Aristol has been highly lauded by Löwenstein,¹ of Elberfeld, as a valuable application. It is to be used by means of an insufflator after the removal of all crusts and the thorough cleansing of the nasal chambers.

Schuster² also recommends aristol as a valuable dressing.

The constitutional treatment should be of such a nature as quickly to arrest the destructive process in the nose. If gummatous deposits be present and are recognized in time, they will readily yield to the proper administration of the iodide of potassium. Under the use of the iodide in full doses a gumma will often show a perceptible reduction in size in the course of a few days. The tendency of this drug to produce gastric irritation must be provided for, and some system of giving it should be adopted with the intention of avoiding that possible complication. If the patient cannot take a dose of twenty grains well diluted after meals, it is best to reduce the amount to ten grains three times daily. The quantity given may be increased by the addition of one grain at each dose, or, if that will not be tolerated, by a grain per dose per diem. The iodide is well borne if administered the last thing at night and the first thing on rising in the morning. When so exhibited it seems to be more active in its effects. It should be given always well diluted in a glass of Vichy, Kissingen, or soda water. If a maximum dose of twenty grains be not sufficient to arrest the disease, the dose must be raised to such a quantity as will effect the desired end. By the iodide of potassium we can gain ground in tertiary syphilis, but we must employ mercury if we expect to hold it. As soon as decided improvement has commenced, we may combine the mercurial treatment with the iodides in some shape or form. The protiodide, the biniodide, and the bichloride are the salts usually ordered. The tannate of mercury, before referred to, will also commend itself for use here.

Of all methods of administering mercury that by inunction is unquestionably the best. In the tertiary stage of syphilis, when the general health of the patient is reduced and the digestive process weakened, it becomes a matter of some consequence that, whatever means are employed, they should interfere in the least possible degree with assimilation. Mercury, when exhibited by the stomach, certainly deranges digestion, and when relaxation of the intestines is superadded it becomes a serious question how much of the original dose is retained in the system to promote the cure and how much is lost in the excreta. Inunction produces less gastro-intestinal dis-

¹ Internationale Klinische Rundschau, Wien, May 18, 1890.

² Monatsschrift für Praktische Dermatologie, Hamburg, vol. x. p. 262.

turbance than any other method of administration, and is better under control, while at the same time we can depend upon the absorption and the activity of the remedy.

It will not do, however, to trust the frictions to the patients, as they seldom possess either the strength or the energy to carry out the treatment properly, and moreover some of the regions are not conveniently accessible. A skilled rubber should be retained for the purpose, if possible, and the Aix-la-Chapelle method followed as nearly as possible. At Aix the patient occupies a large, well-ventilated sleeping-apartment. He rises at 7 A.M. and takes gentle exercise for an hour, at the same time drinking one or two glasses of the thermal waters. He returns to his lodgings at 8 A.M., rests, and breakfasts on bread and coffee, with one or two boiled eggs if required. At 10 or 11 A.M. he takes his bath at 96° F., remaining in the water for from twenty minutes to half an hour. He returns to his room and in the course of an hour is visited by the rubber. The sitting lasts twenty minutes, and from forty-five to seventy-five grains of blue ointment (of the strength of fifty per cent. U. S. P.) are rubbed in on each occasion. This treatment is carried out daily until the physician directs it to cease. The results obtained are often remarkable; cases which had been under practically the same treatment at their homes without any benefit begin to mend almost at once. A modification of this treatment might be carried out anywhere. A bath containing bicarbonate of sodium in solution might be taken daily; an hour afterwards the frictions should be made by a rubber, and a rest of half an hour taken. A mineral water resembling the Aix water should be taken warm every morning, and milk should enter largely into the dietary, while alcoholic stimulants and tobacco should be prohibited. At Aix, iodide of potassium is seldom employed, as the desire is to retain the mercury in the system for as long a time as possible. The teeth and gums should be kept scrupulously clean by means of camphorated chalk powder, and an astringent mouth-wash, such as the liquor aluminis acetatis (Ph. Ger.), should be used very frequently during the day. If there is much anæmia, an iron preparation is called for, and the citrate of iron and quinine or the syrup of the iodide of iron may be prescribed. The potassio-tartrate of iron will be found to be a valuable remedy if there is much destruction of tissue going on, and it may be substituted for either of the combinations before named. Sarsaparilla is also a valuable tonic in syphilis of this advanced type, but it must be given in large quantity. The watery extract obtained from a quarter of a pound of root should be consumed in the day. Cod-liver oil also may be administered with benefit in suitable cases, and need not interfere with the ordinary course of treatment.

The naso-pharynx is involved principally in the late periods of inherited disease and in the tertiary stage of the acquired disease. Destructive changes in this region are, as elsewhere, the result of the breaking down by ulceration of gummatous deposits. Gummata in this region are not as often recognized as they ought to be, and if more diligent search were prosecuted

the disease might be arrested before serious changes had occurred. The favorite sites in the pharyngeal vault for their development are the posterior wall and the soft palate. A gumma of the soft palate may run its entire course and escape detection until perforation has taken place. After ulcerative action there will be great difficulty experienced in keeping the ulcerated surfaces apart. Adhesions are particularly liable to occur, and more or less stenosis of the cavity is the result. A gumma of the soft palate will yield readily to full doses of iodide of potassium. Thorner, of Cincinnati, treats the parts locally with iodine, and expresses a preference for the use of hypodermic medication.

GLANDERS.

Definition.—Glanders is a malignant febrile affection of an infectious nature, caused by a specific micro-organism, the *bacillus mallei*.

It is essentially a disease of the horse tribe, but is capable of being communicated to man and other animals.

Glanders in the Horse.—In the horse the disease is met with under two forms, both characterized by the formation of nodules. When these deposits are found in the lymphatic system, the name of *farcy* is given, and when the nasal cavities and skin are the seat of the lesion, the affection is termed *glanders*. Farcy and glanders are merely different manifestations of one and the same disease; each may by inoculation produce the other, both may coexist, or one may follow the other. In fact, farcy usually terminates with an attack of glanders if the animal live long enough and the disease be not arrested. Both phases of the disease occur in chronic and acute forms, with the anomaly that the chronic malady is never the outcome of the acute, but, on the contrary, precedes it.

Chronic glanders is the most common form of the affection in the horse, and never presents itself as the termination of the acute disease.

The symptoms of chronic glanders in the horse are not always well marked. The Gamgees¹ state that the general health is little, if at all, affected. The submaxillary glands are swelled and hardened, and may be felt adhering to the bone of the lower jaw. The nasal mucous membrane, if carefully examined, will exhibit nodular elevations and ulcerations. The discharge is at first thin and watery, then more thick and glairy, and afterwards becomes opaque, bloody, fetid, and horribly offensive. The discharge may flow from both nostrils, but sometimes only from one, and then generally from the left. A horse thus affected may appear to be in good health. When under bad sanitary conditions, however, or when overworked or underfed, the acute form of glanders frequently develops and rapidly terminates life. According to Youatt,² the *distinctive features of chronic glanders* are the *continuousness of the discharge and the adherence of the large sub-maxillary gland*.

¹ Reynolds's System of Medicine.

² Youatt on the Horse.

The acute form of glanders occurs more rarely in the horse than the chronic, and may be the result of recent exposure to contagion, or be simply due to the development of the acute form during the course of the chronic malady. The disease is ushered in suddenly with marked febrile disturbance and signs of inflammatory action. The nasal mucous membrane is congested and swollen, and in a few days becomes deeply ulcerated. The secretion is purulent, copious, and often bloody. The conjunctivæ swell and inflame, and cough and dyspnœa supervene as the ulcerative action extends in the direction of the lower air-passages. The chief anatomical difference, according to the Messrs. Gamgee,¹ between acute and chronic glanders is the occurrence in the former of true cutaneous abscesses or boils.

Farcy in the horse, like glanders, is most frequently met with in the chronic form, and usually commences with inflammation in the course of the lymphatic vessels, leading to painful swellings of the lymphatic glands called "*buttons*" or "*farcy buds*." These tumors occur chiefly in the situation of the valves of the lymphatics. These latter gradually suppurate, and ulcers form which give vent to an ichorous discharge capable of producing glanders or farcy, or both. The general health may continue good for some time, and the disease show little or no progress. The virus gradually poisons the whole system; all the capillary absorbents inflame, the legs and the head swell, the animal emaciates, the coat stares, a cough supervenes, and death results from acute or chronic glanders.

Acute farcy, which is invariably fatal, may accompany acute or chronic glanders, and is recognized by the gravity of the constitutional symptoms.

Glanders in Man.—When glanders develops in the human subject it is due to infection from a diseased horse, whether by direct or indirect means. It is now considered quite impossible that the disease should arise spontaneously. Infection may arise in a great variety of ways, the principal being by inoculation through wounds or abrasions of the hands. This occurs among those whose business brings them into contact with horses, such as grooms, hostlers, veterinarians, and so forth. The disease may also be transmitted by the virus being driven on to the mucous membrane of the nose or mouth or on the conjunctivæ by the snorting of a diseased animal. The late Sir Morell Mackenzie reported such a case, which occurred to a person who had driven but a short distance in a hansom cab. The horse sneezed, and some of the secretion was blown into the face of the patient, who died shortly afterwards. A similar case is reported in the *British Medical Journal* of January 14, 1888, which occurred in St. Petersburg. Symptoms of glanders made their appearance in this man shortly after his face and eyes had been profusely bespattered with foam from a passing cab-horse, the patient being in the act of crossing the street at the time. It is quite likely that in the case of mucous membranes no breach of surface is required to produce infection. In the skin, a very

¹ Loc. cit.

minute abrasion that would afford ample access of the virus to the system might easily be overlooked. Moreover, in the class of persons whose occupation exposes them most to the dangers of infection one would likely find more or less wounds or abrasions about the hands. Infection may arise from the use of cloths used to cleanse the nasal fossæ of a glandered animal, or from horse-blankets, or from anything on which the discharges have fallen. The disease has also been communicated by a bite. The possibility of contracting the disease through the medium of a volatile infecting principle is open to doubt. Bollinger,¹ however, thinks it likely that in all cases where the disease has occurred without known local inoculation it is attributable to a volatile infecting principle, and he states that this mode of infection may be inferred in all cases in which the general constitutional disease precedes any localization of the symptoms. The communication of glanders from man to man has been known to occur. Bollinger² mentions an instance where a whole family, consisting of a man, his wife, and four children, were attacked one after another with the disease. In 1840 a nurse at St. Bartholomew's Hospital, who had attended a glandered man, contracted the disease from her patient and died in a few days. Decroix³ consumed without serious consequence the meat of horses that had been slaughtered on account of farcy or glanders. The meat was variously cooked. He also asserts that on seven or eight occasions he ate the raw meat of glandered horses. He was most fortunate in the latter venture, as it is a well-known fact that lions confined in menageries and zoological gardens commonly contract glanders from diseased horse-flesh.

The susceptibility of the human species to infection is not great. When we consider the great number of persons whose vocations bring them in contact with horses, the comparative frequency of the disease among horses, and the rare occurrence of glanders or farcy in man, the susceptibility is certainly very moderate.

In one hundred and six cases collated by Bollinger,⁴ the patients were forty-one hostlers, eleven coachmen, drivers, or postilions, fourteen land proprietors and horse-owners, ten veterinary surgeons and students in veterinary medicine, twelve horse-butchers and flayers, five soldiers, four surgeons, three gardeners, two horse-dealers, one each policeman, shepherd, blacksmith, and employé at a veterinary school. About ninety per cent. of the published cases in the human subject come under the classification of industrial diseases.

Symptoms of Glanders in Man.—The latent stage of glanders is probably from three to five days, but in some cases it has exceeded two and even three weeks.

Glanders in man may be either acute or chronic, and as such it will be

¹ Ziemssen's *Cyclopædia of Medicine*, English translation, 1875, vol. iii. p. 351.

² *Loc. cit.*, p. 351.

³ *Bulletin de la Société Centrale de Médecine Vétérinaire*, 1870-71.

⁴ Ziemssen's *Cyclopædia of Medicine*, English translation, 1875, vol. iii. p. 352.

here considered. Bollinger¹ makes a division into acute, subacute, and chronic glanders, and holds that "the distinct line of division drawn by many authors between acute and chronic glanders has no real existence. In seventy-nine cases of glanders in the human subject which admitted of accurate classification, according to their duration, thirty-eight were acute (lasting as long as four weeks), seven were subacute (lasting from four to six weeks), and thirty-four chronic (lasting longer than six weeks)."

Acute Glanders.—The average period of incubation in acute glanders is about three days. The average duration of the illness, which is almost invariably attended by fatal consequences, is about seventeen days. The acute is the form most commonly met with in man, and presents in him, according to the Gamgees, characters most nearly resembling those where *acute glanders* and *acute farcy* are combined in the horse.

Symptoms of Acute Glanders.—The symptoms that usher in the disease are malaise, headache, high fever, shivering, great prostration, and pains in muscles and joints. Frequently, however, the chills and fever are absent. Presently the point of inoculation becomes hot, swollen, and painful, and lymphangitis develops. A glairy yellow discharge flows from the nose, and if the nasal mucous membrane be examined a pustular and nodular infiltration will be found, which soon undergoes ulceration. As the disease advances, a papular eruption, which soon becomes pustular, breaks out on the face and in the neighborhood of the joints. This eruption resembles that of small-pox, for which it is sometimes mistaken. The external nose swells and becomes cedematous, and the point of entrance of the poison ulcerates and assumes a chancreoid character, with a most offensive discharge. The nasal flow becomes thicker and more glutinous, sanious, and fetid. Multiple abscesses form throughout the body. Diarrhœa, vomiting, and profuse sweating frequently occur. Dyspnœa may supervene with a typhoid condition, coma, and death.

Bollinger² states that in acute glanders in man the localization of the disease in the mucous membrane of the nose occurs much less frequently than in the horse.

Chronic glanders in man is a very rare disease. It is characterized by a viscid and peculiarly offensive muco-purulent discharge from the nose, usually from one nostril, accompanied by swelling and pain. The mucous membrane ulcerates, and destruction of the bony framework follows. The disease may run a chronic course and partial recovery may follow. Emaciation, profuse sweating, and abscesses near the joints frequently are observed, and the patient dies of exhaustion. The condition is often mistaken for syphilis.

Prognosis.—Acute glanders is almost invariably fatal. Persons who have suffered from chronic glanders have been known to make a partial recovery; the constitution, however, has been wrecked.

¹ Loc. cit., p. 353.

² Loc. cit., p. 356.

Diagnosis.—Glanders in the human subject is rare. Where a definite history of inoculation is obtainable the difficulty of diagnosis is much simplified.

Should a coachman or hostler, or other person whose duties bring him constantly into contact with horses, present himself with an inflamed pustule and a copious muco-purulent nasal discharge, with rheumatic pains and febrile movement, glanders would, under ordinary circumstances, suggest itself. The pustules and ulcers in themselves are not sufficiently distinctive. Pyæmia might be suspected, but in glanders the shivering is a much-masked symptom and is often altogether wanting.

Glanders might possibly be mistaken for acute rheumatism, for typhoid fever, for syphilis, and for small-pox, but a liberal view of the occupation of the patient and other conditions will help to prevent error.

From carbuncle and charbon it may be distinguished by the fact that in both a local lesion precedes the constitutional disturbance, whereas in glanders the order is usually reversed.

When difficulties of diagnosis arise, resort should be had to cultures. Pure cultures, when inoculated in the guinea-pig, will within twenty-four or forty-eight hours give rise to swelling of the testicles, with abscess (Osler).

Treatment.—Treatment is almost hopeless in acute glanders, while in chronic glanders it may occasionally be successful after a long lapse of time. Treatment must be carried out on general lines. In the absence of any specific remedy, the attention of the physician should be directed to watching indications and symptoms as they present themselves. The patient's strength should be supported by the liberal use of stimulants and a nourishing diet in a concentrated form. The general treatment most applicable is that called for in pyæmia. Abscesses must be opened and treated antiseptically. The symptoms referable to the nose should have especial care, and local applications and washes should be had recourse to with thoroughness and frequency.

Dr. Elliotson¹ considered a weak solution of creasote as a nasal injection of great value. Carbolic acid, properly diluted, might also be used. Peroxide of hydrogen would be well worthy of a fair trial.

DIPHTHERIA OF THE NARES AND NASO-PHARYNX.

Nasal diphtheria may occur as a *primary* affection or *secondarily* by extension of the disease from the naso-pharynx. It also may be of an *acute* or a *chronic* type.

Primary Nasal Diphtheria.—When of a *primary* nature it is very likely to be overlooked altogether, or to be regarded simply as of a catarrhal character. The disease may not be recognized until suspicion is aroused by the

¹ Medico-Chirurgical Transactions, 1830-31.

development of pharyngeal or laryngeal diphtheria in other members of the household. The primary nasal form is decidedly rare, but that it does occasionally occur is amply proved by several recorded cases.

Jacobi¹ states that during the prevalence of an epidemic of diphtheria we must be prepared to see acute nasal catarrh become complicated with diphtheria or pass into it. The same author refers to a case of Schuller's,² in which a child five weeks old, who had been the subject of nasal catarrh from birth, developed primary nasal diphtheria.

Corsan reports (privately) a case of primary nasal diphtheria in a child aged thirteen months. The disease was confined to the nasal chambers, and the exudation lasted about two weeks. The discharge was abundant, flocculent, of a watery consistence, and not offensive. The posterior submaxillary glands were swelled and painful. The child recovered from the disease, to succumb later to cardiac paralysis.

The writer has observed several cases in which the membrane was confined to the nasal chambers, and one in which the left passage alone was involved.

CASE I.—In this instance the child, seven years old, complained of symptoms of acute rhinitis, and, in fact, was prescribed for for that malady. When examined by the writer, about three weeks after the development of the first symptoms above referred to, the nasal chambers were found to be lined with a thick white membrane, which could be removed without much difficulty, and formed an almost complete cast of the cavity. The discharge was abundant, flocculent, of a watery character, and but slightly, if at all, offensive. The posterior submaxillary and cervical glands were somewhat swollen and tender to the touch, but swelling was not a prominent symptom. There had been but little constitutional disturbance. Under the local use of solutions of peroxide of hydrogen, combined with the internal administration of chlorate of potassium and tincture of iron, the exudation ceased to form, and in ten days the child was apparently convalescent. There was subsequently paralysis of the soft palate. In the mean time two younger children, who had been isolated when the true character of the malady was recognized, contracted the disease, and one of them died of it.

CASE II.—In this case an infant, aged five months, was attacked with diphtheria of the pharyngeal wall with laryngeal extension. As no explanation was obtainable to account for the contagion, an examination of all the members of the family was instituted. A boy, aged nine years, was discovered to be suffering from nasal diphtheria which had existed for over two weeks. Both nasal passages were lined with membrane, which had been shed at varying intervals and again reformed. The discharge was watery and flocculent, with a slightly offensive odor. The submaxillary and cer-

¹ Treatise on Diphtheria, p. 72.

² Ibid.

vical glands were slightly but not very perceptibly swollen, and were tender to the touch. The amount of constitutional disturbance was very slight, as the boy had not complained of feeling ill. The infant was intubated, but died from pulmonary extension.

CASE III.—A little girl, aged five years, had suffered from what was termed *low fever* (sepsis) for over three months. On examination, the nasal passages were found to be loaded with diphtheritic membrane, and the posterior submaxillary and cervical glands were very much swollen and very tender. There was no extension into the pharynx, but whether the naso-pharyngeal space was involved or not it is not possible to state with any accuracy, as the faucial tonsils were very much hypertrophied and the pharyngeal vault was filled with adenoid vegetations. A case of scarlatina had occurred in the family during the illness of the child referred to. The nasal case yielded slowly to peroxide of hydrogen and the usual internal administration of remedies. There was mild post-diphtheritic paralysis.

CASE IV.—A child, aged three years, was attacked with tonsillar and pharyngeal diphtheria. Under the hourly administration of chlorate of potassium and tincture of iron all traces of membrane had disappeared in four days. Of the two remaining children, both of whom had been sent to the house of relatives for safety, *one, aged four years and a half, developed nasal diphtheria*, and was returned at once to her own home, not, however, before an adult was seized with a severe pharyngeal diphtheria, which lasted over three weeks. The nasal case (four and a half years) had but little constitutional disturbance; the left nasal chamber was at first the only one involved, and the posterior submaxillary glands on the left side only were enlarged and sensitive. The discharge was flocculent and of a milky consistence. Late in the second week some membrane appeared on the cartilaginous septum in the right nasal chamber, but was not of any extent. By the end of the third week all membrane had disappeared and the child was quite convalescent.

CASE V.—The fifth case is the child referred to with tonsillar diphtheria in the foregoing report of Case IV. On the 17th of March this child, aged three years, was attacked with the disease, and was convalescent in the course of a week. On the 19th of April, a month later, diphtheria developed in the left nostril, but did not invade the right, nor did it extend into the naso-pharynx. The discharge was similar to that reported in the foregoing cases, and the posterior submaxillary glands, as well as the cervicals of the left side, were enlarged and tender when manipulated. The case was further complicated by inflammation of the left middle ear, with rupture of the drum-membrane and the usual purulent discharge. During the second week of the nasal disease the child complained of pains in the lower extremities and stumbled on attempting to walk. A well-marked paralysis subsequently developed. The sterno-mastoid muscles were also paralyzed, so that unless the child's head were supported on a pillow when raised from the bed, the head would fall backward.

Bischofswerder¹ describes what he designates as "rhinitis pseudo-membranosa," in which thick white pseudo-membranes appear on the nasal surfaces of children, while the pharynx is not similarly affected. He did not consider the pseudo-membrane to be a true diphtheria.

Baginsky,² in commenting upon these cases, admits that he occasionally found such exudations upon the nasal mucous membrane without any extension to other regions. Where paralysis succeeds such cases, or where diphtheria is conveyed to others in whom other surfaces are attacked, all doubt concerning the character of the case should be dispelled.

Symptoms.—The first symptom of primary nasal diphtheria is usually more or less nasal obstruction, with consequent noisy breathing and restlessness at night. A thin watery discharge, which soon becomes flocculent, and which may possibly become of the consistence of milk, is noticed. The muco-cutaneous surface is irritated and painful, and on examination of the nasal chambers distinct evidence of membranous exudation is found. The exudation may be removed without much difficulty, when more or less bleeding will result, but the latter is not a marked feature. There is apparently no tendency of the membrane to spread to the naso-pharynx, although the upper lip is sometimes affected. There is but little constitutional disturbance and no appreciable rise in temperature. The *tumefaction of the posterior submaxillary and cervical glands* is frequently the earliest indication of nasal diphtheria, and is one of great diagnostic value. The swelling is not, as a rule, prominent in the primary cases, but manipulation will readily detect enlargement and distinct tenderness on pressure. The symptoms in the primary disease are not of a very marked character, and are, therefore, liable to be overlooked, unless a thorough examination is made under favorable illumination.

Diagnosis and Prognosis.—The diagnosis depends upon the detection of the presence of membrane. Should any doubt exist as to the true nature of the exudation, a bacteriological investigation should be instituted, and should the Löffler bacillus be in evidence there will be no room for error. The peculiar character of the primary disease is that it does not tend to spread from the nasal chambers proper into the naso-pharynx. Sepsis is also rare, differing in this important particular from nasal diphtheria due to extension, where the occurrence of septic conditions is so much to be dreaded. The prognosis, then, may be considered favorable, but much will depend upon the character of the local treatment and the persistency with which it is carried out.

Primary nasal diphtheria may also occur in a chronic form. The late Sir Morell Mackenzie³ recognized a chronic form of diphtheria, and recorded eleven examples where the pharynx or pharyngo-larynx was involved.

¹ Sajous' Annual, vol. i., J. 9, 1889.

² Ibid.

³ Morell Mackenzie, *Diseases of the Pharynx, Larynx, etc.*, p. 104.

These cases were examples of "walking" diphtheria. The duration of the membranous deposit varied from seven weeks to three months. The same authority refers to a case reported by Barthaz,¹ in which the false membrane lasted for several weeks. In Isambert's² case the nasal passages were involved, and the false membrane continued to be expelled and reformed for several months. Jacobowitsch³ describes a case of chronic diphtheria which lasted two months.

At the Annual Congress of the American Laryngological Association,⁴ held at Detroit in June, 1885, the writer reported a case of "chronic membranous rhinitis," the subsequent history of which left no room for doubt as to its being a true chronic diphtheria of the nose of primary origin. The patient was seen for the first time in January, 1885, and complained of complete nasal obstruction. On examination, the nasal chambers were found to be lined with a grayish-white membrane, freely bathed with moisture. The exudation occupied both passages equally, covering the septum and turbinated bodies, and ceased anteriorly at the muco-cutaneous junction and posteriorly at the margins of the choanæ. The false membrane was susceptible of removal with difficulty, and left behind it a bleeding surface. All attempts to wash out the cavities by means of a douche or spray were futile, and a probe could be passed only with difficulty. The orifices of the nostrils were abraded by the discharges. There was a feeling of fulness in the head and disinclination to study, the result of pressure. The membrane, when removed, would re-form in less than twenty-four hours. At the time of the first interview the nasal obstruction had lasted three months. The patient had not been ill, had not suffered from sore throat, and could not in any way account for her condition. She was of a catarrhal family, and had suffered frequently from cold in the head. There was an absence of glandular swelling, and, beyond a little fulness about the bridge of the nose, nothing to be remarked. The condition was regarded as a chronic membranous nasal catarrh, and as such it was described and reported. The treatment adopted consisted in the use every two or three hours of an alkaline and antiseptic lotion. Every second day attempts were made to destroy the tendency to the formation of membrane by means of the galvano-cautery or by acetic, nitric, or chromic acid.

The galvano-cautery and chromic acid yielded the best results. The application of a ten-per-cent. solution of chromic acid would cause the membrane to be shed in a few minutes. Later on, iodide of potassium in ten-grain doses was administered three times daily. After a treatment extending over four months, the membrane ceased to form, and the patient was discharged as cured. Just previous to this her room-mate was attacked with a sore throat, and was attended by her usual medical man, who con-

¹ Bulletin de la Société Médicale des Hôpitaux, 1858.

² Lorain et Lépine, Nouveau Dictionnaire de Médecine, 1869.

³ Archiv für Kinderheilkunde, Bd. x. Hft. 1.

⁴ Transactions of the American Laryngological Association, 1885.

sidered her case to be one of acute tonsillitis. As her progress was not satisfactory, a consultation was called, and the disease was recognized as diphtheria of a severe type. The membrane subsequently extended upward into the naso-pharynx and nose and downward into the larynx, and it was only after a severe illness of a month's duration that recovery took place. This was the only case of contagion that occurred in the residence where over thirty pupils lodged, and not a single case in the school of over two hundred pupils. Until the development of this second case, the true character of the nasal affection was not suspected.

In this instance of primary chronic nasal diphtheria there had not been at any time any constitutional disturbance; the young lady had attended to her duties, and, beyond the discomfort caused by the mouth-breathing, she had no grounds for complaint. The contagious nature of the complaint must have been mild in degree, when it is considered that her room-mate had been exposed for nearly four months before contracting the disease. There was no fetor about the nasal discharges noticed at any time.

Secondary Nasal Diphtheria, or Nasal Diphtheria by Extension.—Nasal diphtheria, when it occurs secondarily to pharyngeal disease or as a concomitant of diphtheria in any other part of the respiratory region, must be regarded as a very serious complication, the danger of septic poisoning being immensely increased thereby. The mouth-breathing engendered by the nasal stenosis which results from the nasal exudation also tends to aggravate the pharyngeal disease by producing local congestion and dryness of the surrounding parts. In all cases of diphtheria it should be the rule to investigate thoroughly the nasal fossæ and naso-pharynx, so that a knowledge of the existence, extent, and character of the false membrane may be acquired. The importance of the early discovery of a nasal complication cannot be overestimated, as means can be employed to dissolve the exudation and thus keep the passages sufficiently patent to permit of the carrying out of thorough antiseptic measures. Where the pharyngeal vault is occupied by adenoid vegetations, it is a matter of the greatest moment that the presence of the hypertrophied tissue should be known, as thorough antisepsis is rendered most difficult of attainment and the greatest care and persistency are required for its accomplishment. When these growths are present the danger of septic poisoning is very much to be dreaded, and should no other reason exist for their removal, the bare fact of the evil influence they are capable of exerting in diphtheria should be considered a sufficient one. At present it is generally conceded that a hyperæmic mucous surface increases the liability to contagion, and there is little doubt that most cases of nasal diphtheria occur in persons suffering from a more or less acute or subacute rhinitis. The writer has observed on two occasions the immunity from diphtheritic exudation enjoyed by cicatricial surfaces. In one instance the stump of an amputated tonsil was free from membrane, when its fellow and all the surface in the neighborhood of both were covered with exudation. In another case a child, aged

ten years, who had swallowed lye in infancy, was the subject of diphtheria of the pharynx. Here the cicatricial tissue was quite free from membrane.

Symptoms.—When nasal diphtheria is an accompaniment of the disease in other regions of the respiratory organs, there is little excuse for oversight. The symptoms are at first those of obstruction to nasal breathing, accompanied by a thin watery discharge which produces excoriation of the muco-cutaneous surface of the nostrils and lip, and possibly extension of the exudation thereon. On rhinoscopic examination, the nasal chambers will be found lined by an ashen-gray membrane which resembles the exudation found elsewhere. As the disease advances, the secretion becomes more plentiful, darker in color, and tends to become offensive.

In some cases the nose and adjoining regions may swell and present an œdematous appearance, or the membrane may extend up the lachrymal duct and form on the conjunctiva. Bleeding from the nose sometimes occurs, and may be profuse and difficult to arrest. It should be regarded as an unfavorable symptom. When the discharge from the nose assumes a tarry character and is very offensive, fatal sepsis is to be anticipated, in spite of the utmost precautions. From the naso-pharynx the disease may extend up the Eustachian tube and produce severe earache, tinnitus, and deafness, with rupture of the tympanic membrane and discharge from the external ear.

Prognosis.—The *prognosis* in secondary nasal diphtheria is always doubtful. The early recognition of the disease and the improved methods of treatment now in vogue have at least robbed the nasal disease of some of its terrors.

Treatment.—Now that the nature of diphtheria is better understood, the indications for treatment are plain and straightforward. Löffler's bacillus is now regarded as the specific cause of the disease. It does not enter into the mucous membrane, and has not been discovered in the blood nor internal organs, but confines itself to the exudation. Here it elaborates a poisonous principle, a tox-albumen, by the absorption of which into the circulation the systemic condition is produced. However important local treatment is when the lesion occupies other regions, it is of far greater moment when the nasal passages are the seat of exudation. Jacobi¹ pointed out the fact that the great danger of sepsis in nasal diphtheria is due to the large number and size of the lymphatic ducts of the Schneiderian membrane, as well as to their direct communication with the lymphatic glands of the neck. The same authority also states that direct infection—that is, the absorption of the poison into the body—is not always dependent on the lymphatics. In cases in which early and slight epistaxis takes place, the poison appears to be absorbed directly into the blood-vessels.

With these facts well ascertained, the local treatment should have for its object the maintenance of the patency of the nasal chambers, whereby access may be had to every portion of the region. The lotions or sprays

¹ A Treatise on Diphtheria, p. 129.

used should not only be capable of cleansing and antiseptic action, but should also be possessed of solvent properties in a high degree. The local treatment cannot be commenced too soon in the illness, nor carried out too frequently nor too thoroughly. The risk of septic poisoning is immensely reduced when prompt and efficient nasal treatment is undertaken. For the purpose of dissolving the membrane and thereby controlling excessive development a variety of preparations have been suggested. Of these peroxide of hydrogen is certainly the best, for it is not only an active solvent, but is also a prompt antiseptic and deodorizer. Statements concerning this remedy are for the most part categorical and conflicting. Professor Welch, of Johns Hopkins University, in a letter to the writer, states that "peroxide of hydrogen does not break up nor destroy nor in any appreciable way alter the appearance of the Löffler bacillus as seen under the microscope." Clinical experience, however, shows that it is capable of disintegrating the membrane so that it is shed, and that if used assiduously, in abundance, and of sufficient strength, it will retard and prevent the formation of fresh exudation. What its influence is on the tox-albumens it would be difficult to estimate, but in dissolving the membrane it gains access to the subjacent mucosa and exerts its antiseptic and deodorizing properties. The results obtained from its use are eminently satisfactory in practice. Peroxide of hydrogen, moreover, in no way interferes with the use of other chemical agents whose germicidal powers are fully established. On the contrary, as a solvent it assists their action by giving them access to the bacilli in the substance of the pseudo-membrane. The fifteen-volume solution of the peroxide of hydrogen is the preparation usually employed. It is not advisable to trust to all commercial preparations, as they vary much in strength and purity. A *medically pure* standard preparation is necessary, such as that known as Charles Marchand's. The peroxide requires to be kept at a temperature not exceeding 70° F., otherwise much of its activity is lost. When dispensed at a chemist's, precautions should be taken to ascertain that the preparation has been properly corked and that it is otherwise reliable. As the peroxide is not a poison, it is particularly applicable to cases of nasal diphtheria in children, as, if swallowed, it can do no harm and is in itself a valuable remedy for internal administration in the disease. For use as a lotion the fifteen-volume solution is reduced by the addition of one or two parts of water and applied by means of a suitable syringe, douche, or spray. The method of using the instrument is of some importance. Not only should the nurse be carefully instructed how best to make the application, but means should be taken to see that the directions are carried out to the letter. The nose should be douched every hour at least, every half-hour, or even every fifteen minutes, if necessary. The quantity used at each sitting will vary with the character of the case. Should there be much difficulty in gaining access to the nasal chambers, the instillation of a few drops of a four-per-cent. solution of hydrochlorate of cocaine will not be found amiss.

Other solvents that have been recommended are lactic acid, twenty-five grains to the ounce of water; lactic acid, twenty-five grains to the ounce of lime-water; lime-water; papayotin, twenty-five grains to the ounce; pepsin, sixteen to twenty grains to the ounce of water, slightly acidulated with hydrochloric acid, to which a little glycerin might be added; and trypsin, thirty grains to the ounce.

Cholewa¹ recommends the use of a twenty-per-cent. solution of menthol in cases where occlusion of the nostrils with membrane prevents the use of the syringe. The menthol is introduced into the nose by means of cotton plugs.

All these means are in every way inferior to peroxide of hydrogen; they are not equal to the latter as a solvent, and do not, moreover, possess the antiseptic and deodorizing properties of the peroxide.

Any of the following solutions may be employed for purposes of cleansing and disinfection:

Corrosive sublimate, one part in one, two, three, or four thousand parts of water; carbolic acid in two-per-cent. solutions; boric acid in a saturated solution; or any alkaline and disinfecting wash.

The best combination for local treatment would be the use of the peroxide of hydrogen, followed by the corrosive-sublimate solution.

Powder may be applied by insufflation after using the douche, such as boric acid, iodoform, iodol, or aristol, or combinations of these with carbonate of bismuth or other vehicle.

Great care should be exercised to avoid wounding or abrading the nasal mucous membrane by contact with instruments.

When epistaxis occurs, it should be treated by injections of tannic acid in aqueous solution, or by liquor ferri perchloridi. Plugging, for obvious reasons, should not be resorted to.

The atmosphere should be kept moist with the steam of hot water, or some medicated vapor may be used, such as—

R Acidi carbolici,
Ol. eucalypti, āā ℥i ;
Spts. terebinthinæ, ℥ viii. —M. (J. Lewis Smith.)

Sig.—Add two tablespoonfuls to one quart of water in a shallow pan, and simmer in the room occupied by the patient.

OR:

R Creasoti, ℥ iiss ;
Alcoholis, ℥ iii ;
Aquæ q. s. ad ℥ xxx. —M. (Legroux, Paris.)
Sig.—To be vaporized constantly.

The proprietary preparation known as "cresoline," when vaporized, is also a very satisfactory means of disinfecting the atmosphere, and certainly relieves the nasal stenosis in a very remarkable manner.

¹ Sajous' Annual, vol. i., J. 32, 1889.

The *constitutional treatment* should be characterized by energy and completeness. The usual method of administering tincture of iron and chlorate of potassium in combination with glycerin still gives good results when carried out intelligently. The necessity for *hourly doses day and night* is very much to be insisted upon. The success of the treatment will depend upon the regularity with which the medicine is given. The idea seems to prevail that chlorate of potassium is a dangerous drug, owing to its alleged tendency to produce nephritis. The writer, in a very extensive and varied experience of the use of chlorate of potassium (with iron), has not met with any cases where nephritis caused any trouble.

R Potassii chloratis, ℥ ii;
Tinct. ferri mur., ℥ vi;
Glycerini puri, ℥ ii;
Aquæ q. s. ad ℥ vi.—M.

Ft. mist.

Sig.—One dessertspoonful every hour.

The activity of the above is said to depend upon the lower oxides of chlorine evolved. The amount of chlorate of potassium should be in excess. In the diphtheria wards of the Montreal General Hospital the hourly administration of the same medicine had the effect of reducing the mortality to nearly half what it was when the doses were given at intervals of three and four hours.

Peroxide of hydrogen may be administered internally; half-drachm doses with water may be given every second hour.

Bichloride of mercury is highly recommended, and may be given to the extent of half a grain in the twenty-four hours to children four or five years of age. It should be very largely diluted,—about one to ten thousand in milk or water.

Alcoholic stimulants should be administered freely from the first. The amount to be exhibited daily will depend upon the gravity of the case. A child two or three years old will often consume with benefit from four to six ounces of brandy in the twenty-four hours. The tolerance of alcohol is remarkable in this disease.

There must be no hesitation about arousing a sleeping child for the administration of medicine, nutriment, or stimulants, or for the carrying out of local applications. It must be remembered that the drowsy condition is the result of the poison, and to permit a child to slumber is simply to endanger its life.

FOREIGN BODIES IN THE NOSE, AND EPISTAXIS.

BY E. CRESSWELL BABER, M.B. (London),

Brighton, England,

Surgeon to the Brighton and Sussex Throat and Ear Hospital; Late President of the Brighton and Sussex Medico-Chirurgical Society.

PART I.

FOREIGN BODIES IN THE NOSE.

FOREIGN bodies in the nose may be divided into—

1. Inanimate (including rhinoliths).
2. Animate.

INANIMATE FOREIGN BODIES.

These may gain access to the nasal cavities in one of three ways, either through the anterior nares, through the posterior nares, or through the walls of the nasal cavity, as occurs in gunshot wounds. The introduction of foreign bodies through the nostrils generally occurs in children or lunatics. Anything of suitable size or shape may be found there, some of the most common objects being beads, peas, leaves, buttons, cherry- and plum-stones, paper or rag pellets, stones, sponges, pieces of wood, coins.

The entrance of foreign bodies through the posterior nares is generally the result of vomited matters being forcibly thrown into the nose, or may be caused by a person "swallowing the wrong way,"¹ the effort to prevent the foreign body from entering the larynx driving it up into the nose. Paralysis of the soft palate doubtless precipitates the occurrence of both these accidents. I have seen in the practice of another surgeon a very free removal of the tonsils subsequently cause entrance of food into the nose on deglutition. Plugs may be accidentally left in the nose after plugging for epistaxis. Foreign bodies introduced through the walls of the nasal cavities are usually bullets lodging in this position. Teeth have been known to enter the nasal cavity, and a case is recorded by Moldenhauer² in which a splinter of wood made its way through the canine fossa and was removed from the inferior meatus some months later. According to this author, foreign bodies are more common at the right side, on account of the right

¹ Morell Mackenzie, *Diseases of the Throat and Nose*, vol. ii. p. 441, London, 1884.

² *Die Krankheiten der Nasenhöhle*, Leipzig, p. 123, 1886.

nostril being more handy for their insertion ; but I am not aware that any observations have been brought forward in support of this statement. Fungi, such as *oïdium albicans* and *aspergillus*, are occasionally met with in the nose.

Symptoms.—Occasionally a foreign body, especially if hard and smooth, may lie in the nasal cavity without there being any symptom to attract the patient's attention to it. (Compare author's Case I. of rhinolith, in which a boot-button occupied one nasal cavity for over twenty years without producing any noticeable symptoms.) But usually a foreign body causes more or less obstruction, and a discharge at first mucous, afterwards thick and fetid. There is often pain of a neuralgic character, and sneezing and anosmia are said to occur when the foreign body is lodged in the front part of the nasal cavity. Vegetable bodies, such as peas and beans, swell up and may germinate in the nasal cavities. Morell Mackenzie¹ quotes cases of Renard, Boyce, and others in which the latter took place ; but it cannot be of at all common occurrence, as I have not found any cases of germination *in situ* recently reported.

Diagnosis.—The occurrence of a unilateral fetid discharge from the nose, especially if in a child and accompanied by obstruction, should lead to the suspicion of a foreign body. No reliance can be placed on the history in children : on the one hand, children are frequently brought with a supposed foreign body in the nose where none exists ; on the other hand, when a foreign body is found there is often no history of its introduction. In adults the offending substance may have been introduced so long ago that no reliable history can be obtained.

The diagnosis is made by rhinoscopy (anterior and posterior) and palpation with a probe. The latter is often of very great help in these cases, as the foreign body may be completely hidden from view by granulations and swollen mucous membrane. In small children the presence of a foreign body can be excluded by the probe when it is difficult to get a view of the deeper parts of the nasal cavity. The usual position for a foreign body when introduced from the front is between the inferior turbinated body and the septum.

Prognosis.—The prognosis is favorable, as the foreign body can generally be removed without difficulty, and the symptoms then disappear.

Treatment.—The treatment consists in removal, though, as Morell Mackenzie remarks, there is no occasion for undue haste, as the condition is not itself dangerous. If after the application of cocaine there be a difficulty in keeping the patient quiet (whether he be a child or an adult), it is advisable to give a general anæsthetic, in order that the foreign body may be extracted from the front if possible. But before any attempts at removal are made, the situation, size, shape, and fixedness of the foreign body should be accurately determined. The instruments most suitable for removal are scoops of various sizes and curvatures (if the body is impacted, they must

¹ Op. cit., p. 440.

be of steel, and strong), forceps with long thin blades, and snares which can be tightened round the body and so used to remove it. When the body is deeply situated, it may be more convenient to push it back into the nasopharynx, receiving it there with the tip of the index-finger. Douching from the front is not to be recommended. If used at the obstructed side, it would only drive the body backwards; if on the other, there would be great risk (unless the foreign body were very small) of the liquid's entering the tympanic cavities. Douching from the back is probably less likely to do harm, though one would think it of doubtful service. Sajous's method¹ of removing foreign bodies far back may be tried if other means fail. It consists in passing a piece of wire through the nasal cavity and out through the mouth, attaching a tampon of cotton-wool or linen and introducing it through the nostril. In the case of a pebble difficult to remove, the same author passed two wires into the mouth, one above, the other below the stone, fastened the two with a piece of broad tape, and extracted the stone in the loop thus formed. Soft foreign bodies which are wedged in tightly should, according to Voltolini, be bored through with a galvano-cautery point and thus reduced in size, and he even recommends this method for harder substances. Betz² relates the case of a child aged four, from whose nose he was unable to remove a foreign body, but succeeded in dividing it with the galvanic cautery and removing the pieces with forceps. It proved to be the tooth of a vulcanite comb. If thought advisable, preliminary attempts at removal may be made by causing the patient to blow his nose, by exciting sneezing, or by using the Politzer bag in the opposite nostril; but the latter means must be used with care.

RHINOLITHS.

When foreign bodies remain long in the nose they often become coated with a deposit of calcareous salts from the nasal secretions, and then form what is known as "rhinoliths" or "nasal calculi." Though without doubt this is the usual history of a rhinolith, others have been described in which no nucleus could be detected. Possibly the nucleus may have consisted of some soft substance, such as a lump of mucus or blood-clot, which has subsequently become melted down. Any foreign body may form the nucleus. One of the commonest is a cherry-stone. In the three cases, reported below, which have come under my care, the nucleus has been formed respectively by a boot-button, a plug of folded rag, and a glass bead. Rhinoliths used to be considered of very rare occurrence, but, doubtless owing to the increased attention which has of late years been devoted to the study of nasal diseases, they cannot be regarded in that light now. No fewer than fifty-eight instances have been recorded in the *Centralblatt für Laryngologie, Rhinologie, etc.*, since the commencement of that journal in July, 1884.

¹ Lectures on Diseases of the Throat and Nose, p. 213.

² *Monatsschrift für Ohrenheilkunde*, No. 12, 1878, p. 155.

Rhinoliths are usually irregular in shape, and mammillated on the surface, from the mode in which the accretion of salts takes place; but occasionally they are more rounded and may present a smooth surface. Their weight varies greatly. In a case recorded by Mackenzie and Saunders (see farther on) it was as much as two hundred and twenty-five grains; and one recorded by W. N. Browne¹ weighed three drachms and thirty-three grains. Some of the largest have been observed in tropical climates. Thomas Headley, of Jeypore,² describes a calculus weighing seven hundred and twenty grains and measuring two inches by seven-eighths of an inch, Edward Bovill (India)³ one weighing one hundred and sixty-five grains, and M. D. Moriarty (India)⁴ one weighing one hundred and twenty grains.

Symptoms.—The symptoms produced by a rhinolith are the same as those caused by foreign bodies, though the symptoms of obstruction, fetid discharge and hemorrhage, are usually more marked, and possibly of longer duration, in the former case. As above mentioned, Case I. shows that a foreign body may remain in the nose for over twenty years, becoming gradually coated with deposit, without producing any symptoms to attract even an intelligent patient's attention. Reflex nasal symptoms are often also caused by a rhinolith. The objective symptoms are those of a foreign body, excepting that the surface of the offending substance, instead of being perhaps soft and smooth, is hard and tough, owing to the irregular manner in which the deposit generally occurs. This is shown in the figure on page 737. It is very common for a rhinolith to be hidden from view by granulations; and until these, together with any secretion present, are removed, its presence can be ascertained only by the probe. It may be visible from the back (see Case III.). Rhinoliths are, as a rule, less movable than foreign bodies, but often, as in Cases I. and III., they can be slightly shifted with a probe.

On account of the length of time they take to form, rhinoliths are usually met with in adults; but my own Case II. occurred in a child aged twelve years, and other cases in children have been reported by Koehler⁵ (at thirteen years of age), Masini⁶ (at nine years of age), and Clark⁷ (at six years of age).

Secondary Consequences.—As secondary consequences may be mentioned distortion of the bones produced by the prolonged sojourn of rhinoliths. This is instanced in two of my cases. In Case I. the septum was markedly deflected to the right (the opposite) side, and in Case II. not only was the septum bent to the right side, but on the left (the affected) side the anterior

¹ Quoted by Morell Mackenzie, op. cit., p. 445.

² British Medical Journal, December 11, 1886.

³ British Medical Journal, October 16, 1886.

⁴ British Medical Journal, April 10, 1886.

⁵ Centralblatt für Laryngologie, vol. iii. p. 270.

⁶ Gazzetta degli Ospitali, June 4, 1888.

⁷ Albany Medical Annals, 1883, vol. iv. p. 34.

wall of the nasal cavity was bulged and the left malar bone was more prominent than the other. Concavities on the inferior turbinated body corresponding to the rhinolith are of common occurrence, and were found in Cases I. and II.

Diagnosis.—The diseases with which rhinoliths are most likely to be confounded are—1, carcinoma; 2, caries; and, 3, osteoma. Carcinoma only resembles a rhinolith in its general symptoms of obstruction, fetid discharge, hemorrhage, formation of granulations, etc. Careful objective examination with the use of a probe ought to clear up the case without difficulty.

Carious bone due to syphilis produces, in my experience, much more marked fetor than a rhinolith, although a loose piece of bone may at first simulate the latter. There is generally also evidence of the loss of bony parts in the nasal cavity, not to mention other signs of syphilis. Of osteoma I have no personal experience. It is said to be distinguished by the greater hardness of its surface as tested by a sharp probe.¹ It must not be confounded with calcification of the mucous membrane, which has been described by B. Fränkel and others as occurring in the noses of old people.

Prognosis.—The prognosis is entirely favorable as regards cessation of irritation and discharge when the rhinolith has once been removed. Any granulations (such as those on the septum in Cases I. and III.) disappear either spontaneously or under very simple treatment. Secondary distortions of the bones are not likely to disappear.

Treatment.—When a rhinolith has been diagnosed, its removal should be attempted, either with or without a general anæsthetic. In children general anæsthesia is, as a rule, necessary, but in adults attempts to remove it after a free application of cocaine may first be made. If small, it may be extracted entire, the instruments used being the same as those for a foreign body. If large, it will have to be broken up with forceps or a lithotrite, as in a case recorded by Morell Mackenzie.² The case is an interesting one. It is that of a government official, aged sixty-three, in whom there was a large rough grayish-black stone filling the left nasal cavity. After breaking it with bone-forceps and lithotrite, Mackenzie removed portions of calculus weighing seventy grains, leaving a small fragment in the extreme upper part of the nose. The patient suffered from facial cellulitis, and after this had to return to Jamaica. The sequel to the case is to be found in the Proceedings of the Jamaica Branch of the British Medical Association.³ A few weeks after his return, Dr. A. R. Saunders found the nostril “entirely blocked by the calculus, which lay embedded in a kind of hollow it had formed for itself in the floor of the nostril.” It was seized and crushed with strong necrosis forceps, being steadied by a finger in the posterior naris. The fragments removed at the last operation weighed one hundred and fifty-five grains,—making a total of two hundred and twenty-

¹ Morell Mackenzie, *op. cit.*, vol. ii. p. 388.

² *Op. cit.*, vol. ii. p. 447.

³ July 25, 1888.

five grains. As this was accomplished *per vias naturales*, it must be extremely rare for an external operation to be required for the removal of a rhinolith; although McBride¹ has seen a case in which this was necessary.

CASE I.² *Rhinolith with boot-button as nucleus*.—A neighboring medical practitioner consulted me on April 4, 1885, suffering from a discharge from his left nostril.

He stated that for the last two or three months he had had a discharge from the left nostril. In the daytime it would be watery, but in the night there was a thick discharge, sometimes tinged with blood, which soiled his pillow. If he lay on the right side, it did not discharge as much as when lying on the left side. He had suffered no pain, neither had he noticed any nasal obstruction. He fancied the discharge was at times rather fetid. He had not suffered from his ears. There was no history of any reflex nasal symptoms.

On examination, the external nose presented no distinct deflection of the dorsum. Both *alæ nasi* were reddened at the posterior part, the left much more so than the right. The right side was free to the passage of air; the left was much obstructed. On anterior rhinoscopy on the right side, there was seen to be a large deflection of the septum into the cavity, and the inferior turbinated body was somewhat swollen, otherwise normal. On the left side, the anterior nostril was filled up with thick discharge and granulations. By posterior rhinoscopy, the turbinated bodies were plainly seen, and were normal on both sides. After syringing the anterior nares, I found between the anterior end of the left inferior turbinated body and the septum a black substance, presenting to the probe a very irregular surface. It was quite hard to the touch, and movable. Only a small portion of it was exposed, the remainder being covered with granulations and swollen tissue. I tried to seize it with forceps, and to get a hook round it; but, though I could move it, I desisted for the time on account of the pain and free bleeding which ensued, and directed the patient to syringe with salt and water and to return in a day or two. On questioning him carefully, he remembered distinctly, when three or four years old, putting a black boot-button into his nose, but he did not remember into which side; neither had he any recollection of its coming out again. He had not the least idea of its being in his nose, not having thought of it until questioned, and having had no inconvenience from it whatever till the last two or three months, when he had the discharge. Two days later (April 3), I had a letter saying that after my examination of his nose he could distinctly feel that I had moved something which, pressing on some nerve, gave him neuralgic pain in the eyeball. This induced him, on his arrival at home, to try to shift the offending body. After a few attempts, he succeeded in bringing out, in three or four pieces, the offending button.

¹ Diseases of the Throat, Nose, and Ear, p. 326, Edinburgh, 1892.

² Abbreviated from British Medical Journal, October 17, 1885.

When seen on April 7, he stated that he had since had some bleeding, but that the discharge had ceased. The left nostril was freely pervious. On examination of the left nasal cavity, the septum presented, opposite the anterior end of the inferior turbinated body, a small dark-reddish mass, like a granulation with dried blood, which felt quite soft to the probe. Behind and above this point the septum was deflected to the right. The anterior end of the inferior turbinated body was much flattened, and showed a concavity into which the foreign body had evidently fitted. The palatal movements on deglutition were plainly seen through the inferior meatus. The remaining structures, including the middle turbinated body, were fairly normal.

The following are the chief points from a report on the foreign substance by Dr. Sheridan Delépine, Pathologist to St. George's Hospital. From this it will be seen that the body, though originally a boot-button, has, in the course of years, become so coated by deposit from the nasal secretions as to form a true nasal calculus or rhinolith.

The weight is a little less than half a gramme, or nearly seven grains. (This is only an approximative weight, as the calculus had been broken when I received it, and it is possible that some fragments may have been lost when the specimen was cut; also some blood must have remained attached to the concretion, as seems to be shown by the percentage of organic matter.) The dimensions are approximately the following: length, five-eighths of an inch; width, three-eighths of an inch; thickness, three-sixteenths of an inch. The shape is irregularly oval, somewhat rhombic; the surface slightly nodulated and mammillated (this is best seen under a low power, about $\times 5$), and shows here and there small depressions, hemispherical, giving those parts of the specimen a sluggy look). The general color is dark reddish brown, almost black in certain places; in other parts it is more rusty, whilst the greater part of one surface is covered with a paler reddish yellowish white (ochraceous) deposit, which at one point is almost perfectly white, partly colorless, evidently crystalline (some phosphatic crystals). The calculus feels hard and rough; it is brittle; in the attempt to cut it, it was broken into two large fragments and a number of smaller angular ones. The section shows an irregular flattened central cavity, the walls of which are very unequal in thickness, being very thin on one side, less than three-quarters of a millimetre, and rather thick on the other (about one and a half to two millimetres). They are distinctly laminated on the thin side. The broken surface of the walls is irregular, somewhat angular, and crystalline, showing here and there dark shining surfaces.

Chemical Analysis.—A rather large proportion of organic matter is found by incineration of the fragments, more than thirty-five per cent., out of which, however, something must be allowed for the decomposition of the carbonates, which are abundant in this calculus, as shown hereafter. It must be also remembered that part of the fragments and dust examined

was probably dried blood. What remains after incineration is practically entirely soluble in hydrochloric acid, with which it gives a bright brownish-yellow solution. This solution, when tested in the ordinary way, is found to contain a large proportion of iron, and some calcium. It is also found to contain a large quantity of carbonic acid, and a distinct amount of phosphoric acid. A doubtful reaction also led me to believe in the presence of tin, but I have not been able to confirm this on further examination, not wishing to destroy the calculus for that purpose. The analysis gives, therefore, the following results: inorganic matter sixty-three per cent.,—namely, iron (very large amount), calcium (small quantity), magnesium, sodium, phosphoric acid, carbonic acid; organic matter with carbonic acid and ammonia, thirty-seven per cent.

It is probable that the calculus is composed of the following salts and elements: carbonate and oxide of iron, possibly phosphate; carbonate and phosphate of calcium; phosphate of magnesium and ammonium; organic matter.

The quantity of iron salts (more than thirty per cent.) precludes *in toto* the idea of the concretion being formed in the organism. The iron must have been almost entirely introduced from without. The history furnishes the clue to the origin of that iron; therefore there can be no doubt that the patient's recollections are correct, and that the button must have remained impacted in his nose for twenty-five years.

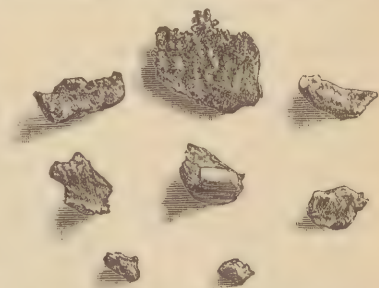
CASE II.¹ *Rhinolith—Nucleus consisting of plug of rag—Distortion of upper jaw.*—N. B., aged twelve, was admitted a patient at the Throat and Ear Dispensary on December 16, 1886. She had had an offensive discharge from the left nostril for six years, with bleeding. There was no known cause. Neither she nor her mother remembered anything being put into the nose; but when young she had a habit of swallowing cherry-stones. There is epiphora on the left side when she is exposed to the wind. On examination, the left side of the nose and the left cheek were bulged out; the left nasal passage was impervious to air, the nostril on that side being contracted and its edges excoriated. Anterior rhinoscopy showed, on the right, considerable deflection of the septum towards that side; on the left, the anterior naris blocked by large soft granulations. Behind these, and completely hidden from sight, the probe revealed a hard body about one inch and a half distant from the tip of the nose. On December 18, with the assistance of my colleague Mr. Treves, the patient being under chloroform, this body was removed through the nostril with scoop and forceps. Afterwards no roughness could be detected with a probe, and the instrument passed easily through into the naso-pharynx. Subsequent examination showed that the left nasal cavity was much dilated, allowing the naso-pharynx to be plainly seen through it. The inferior turbinated bone was much wasted, and presented a deep concavity about its centre. By cleans-

¹ London Lancet, April 16, 1887.

ing the nostril and touching some remaining granulations with solution of caustic, the discharge has now (February 28) almost ceased, and has entirely lost its disagreeable odor. No diseased bone has been detected. The left cheek still appears larger than the other, and the malar bone more prominent on that side, the inequality being apparently due to the long sojourn of the nasal calculus. The rhinolith was more or less filbert-shaped, and had, as usual, a rough mammillated surface. When dry, it measured approximately $18 \times 13 \times 8$ millimetres and weighed nine grains. On section it was found to consist of tightly-packed folds of ordinary rag, on which the salts of the nasal secretion had become deposited.

CASE III.¹ *Rhinolith, with a glass bead as nucleus*.—Mr. W., aged thirty-three, consulted me on August 15, 1887, with the following history. The previous autumn he had suffered from a bad cold, and since that time had had an intermittent mattery discharge, mixed with blood, from the left nostril. At times the left side of his nose was obstructed with a watery discharge; but it was generally clear. On examination, the left nostril was found partially obstructed. The middle turbinated body and upper part of the nasal cavity were normal; but deep in the inferior meatus there was a hard, irregular, movable body. After the injection of some ten-per-cent. solution of cocaine, part of this was removed with a steel scoop, considerable force having to be used. As this made him feel faint, I decided to remove the remainder under chloroform. The following day (August 16) he reported that some more pieces of rhinolith had come away, one large piece of which had escaped through the throat.

From behind the rhinolith could be distinctly seen as a white mass between the septum and turbinated bodies, extending more than half-way up the posterior septum. From the front a hard white mass was still felt and seen in the inferior meatus. Two hours later he returned with a thin shell of calculus (measuring approximately 15×11 millimetres) which had come away through the posterior naris. At four P.M. on the same day, under anæsthesia, I removed with forceps through the anterior naris two more pieces of calculus, one of which (the central one in the figure) contained a black glass bead. The whole mass, when dry, weighed sixteen grains.



Fragments of calculus in Case III. showing mammillated surface produced by the deposit. Natural size.

August 17.—Nose comfortable,—quite clear excepting a small granulation on lower part of septum. This soon disappeared, and the discharge ceased. Patient denied any knowledge of inserting the bead.

¹ Journal of the Respiratory Organs, May, 1889.

ANIMATE FOREIGN BODIES.

In temperate climates the entrance of living creatures into the nose is very rare, but cases have been recorded in which leeches have been found in the nasal cavities, also ascarides, centipedes, and earwigs.

The symptoms are pain, bleeding, sneezing, lachrymation, and possibly cerebral excitement. If sternutatories fail to remove them, they may be removed by syringing or instrumentally in the manner already described for inanimate foreign bodies.

In the tropics (India, Mexico, South America) the entrance of maggots into the nose, forming the disease known as "Peenash," is not uncommon.¹ Ova in large numbers are deposited in the nasal cavities by several varieties of flies, allied to our bluebottle or meat fly. The *Lucilia hominivora* is said to be the commonest, and a fetid discharge from the nose probably attracts the insect.

Symptoms.—The symptoms are irritation, tickling, sneezing, followed by sanious discharge, œdema of the face, especially of the eyelids, and severe headache. The maggots destroy not only the mucous membrane but also the cartilages and bones of the nose. In fatal cases death ensues from coma, preceded by convulsions.

Diagnosis.—The diagnosis can be made with certainty only by the discovery of the maggots in the nasal cavities; and in hot climates the term "Peenash" is doubtless sometimes loosely applied to other cases in which there is a fetid discharge from the nose, such as ozæna or syphilis.

Treatment.—Inhalations of chloroform, injections of equal parts of chloroform and water, and even of pure chloroform (when the patient is under an anæsthetic), are recommended as the most successful modes of treatment.

PART II.

EPISTAXIS.

Epistaxis, or bleeding from the nose, is a symptom of very common occurrence.

Etiology.—It is caused by the rupture of a blood-vessel, usually venous, in the nasal cavities, their accessory cavities, or the naso-pharynx. It may be due to—1, injuries; 2, local diseases of the nose; 3, general diseases; or, 4, it may be of the nature of vicarious epistaxis. 1. Injuries include blows on the nose, "picking" of the nose (especially the septum), and the entrance of foreign bodies. Epistaxis is also a symptom in fractures of the base of the skull. Hemorrhage may occur after operative procedures in the nose, such as the removal of growths. I have very rarely found it at all troublesome

¹ A full description of this disease is to be found in Morell Mackenzie's Handbook, from which most of the above details are gathered.

after intra-nasal operations; never after the removal of adenoid vegetations of the naso-pharynx. 2. Local diseases giving rise to this symptom need not be mentioned: they are referred to under other headings in this work. 3. General diseases act by affecting the state of the blood, the tension of the vessels, or the walls of the vessels themselves. Affections of the heart, lungs, liver, and kidneys, hæmophilia, plethora, anæmia, febrile disorders, such as scarlatina, measles, relapsing fever, and diphtheria, may be enumerated amongst these causes. 4. Vicarious epistaxis is the form in which this symptom takes the place of the menstrual flow in women, or of some periodical loss of blood from hemorrhoids or elsewhere. At times epistaxis is strongly hereditary (Babington¹); but whether in the case referred to hæmophilia was present or not is not stated.

Pathology.—The hemorrhage may take place from any part of the mucous membrane. The consensus of recent opinion,² with which my own agrees, is that the most common situation for a vessel to rupture is at the anterior inferior part of the septum. More rarely does this occur on the turbinated bodies. The reason appears to be that, whilst this region is more exposed to accident, the vessels are, for anatomical reasons, probably less able to contract when injured than those in the turbinated bodies. Blood may also pass into the nose from injury or disease in the naso-pharynx.

Bosworth³ is of opinion that slight deformities of the septum are often the cause of epistaxis, a slight erosion occurring at the apex of the projection as the result of attrition by the dust-laden current of the inspired air. Crusts then form, which are apt to be picked away by the finger. These projections both on the cartilaginous and osseous septum are, however, so very common that it would appear as if they could hardly of themselves be the cause of the bleeding.

Diagnosis.—Blood passing up from the fauces, larynx, or stomach through the nasal passages might be mistaken for epistaxis, though distinguished without difficulty. Of more importance is it to remember that blood found in the mouth in the morning may come from the nose or naso-pharynx, especially, in my experience, from the latter. Rhinoscopic examination (anterior and posterior) will generally decide the point, and in examining the pharyngeal tonsil it may be noted that the use of a palate-hook, such as J. A. White's, is of especial value.⁴ The venous character of the blood, according to Bosworth, would indicate the nose or throat as its source. I have repeatedly seen spontaneous hemorrhage from the pharyngeal tonsil

¹ See Morell Mackenzie, *op. cit.*, vol. ii. p. 344.

² *E.g.*, Chiari, Baumgarten, Voltolini, Moldenhauer, Bosworth, MacDonald, and McBride. Chiari found that out of twenty-five cases of spontaneous epistaxis in twenty-two the source of hemorrhage was on the septum. Morell Mackenzie forms an exception when he states that in the majority of cases the hemorrhage comes from the outer wall just inside the nose.

³ A Treatise on Diseases of the Nose and Throat, vol. i. p. 311, 1889.

⁴ See papers by the writer, *British Medical Journal*, January 12, 1889, and June 28, 1890.

in disease of that structure, but it has never been to any extent, except after operations.

Treatment.—Some hemorrhages from the nose are considered salutary, and therefore best not arrested. This is a doctrine, however, which may be readily carried too far. When it has been decided to arrest the hemorrhage, the ordinary simple means may be tried; but if these fail, and in every case of recurrent hemorrhage, the nose should be carefully examined with the reflector and speculum. The simple measures referred to are so well known as scarcely to require enumerating. They consist of compression of the alæ nasi with the finger and thumb, the application of hot or of iced water to the outside of the nose, back of the head, or spine, injection into the nose of iced salt-and-water, of hot water, solutions of astringents such as alum, tannin, matico, and the application of a four-per-cent. solution of cocaine on pledgets of cotton pushed into the cavity, or in an oily emulsion used in an atomizer (Bosworth), etc.¹ Antipyrin, either in a watery solution of one to thirty, or insufflated as a powder, is recommended by Lavraud and its value endorsed by Bosworth.

Not much knowledge is required to recognize the bleeding spot when situated on the cartilaginous septum near the anterior naris; but when it proceeds from the deeper parts more skill is, of course, required. To find the bleeding point when the hemorrhage is free is not always an easy matter, but much may be done by carefully mopping out the cavity with pledgets of absorbent wool on holders (pieces of stiff roughened wire), combined, if necessary, with injections of an iced solution of common salt and examining immediately afterwards. The patient's head is to be kept upright, a position which of itself often averts slight hemorrhages. The bleeding spot once clearly recognized, the application of a little liquor ferri perchloridi fortior (B. P.) on a small mop of cotton-wool, or, better still, a galvano-cautery point at a dull red heat, will generally arrest it at once. Other authors recommend chromic acid and nitrate of silver for this purpose, or, in an emergency, a silver probe heated to a dull red heat over a spirit-lamp. In a case in which the bleeding has ceased the spot may be recognized by a little blood-clot, a scab, or more commonly, as I have found, by a small area of dilated vessels. The spot is often so close to the nasal orifice that it is necessary to use a fenestrated speculum (such as Fränkel's) or it may be overlooked.

There can be no doubt that the more common the practice becomes of examining the nose in this manner the less frequently we shall have to resort to plugging the nostrils. In my own practice I have met with several severe cases of epistaxis, but hitherto have had no occasion to plug the nose back and front. In the following case, for instance, unless the nasal cavities had been examined, plugging would doubtless have been resorted to.

¹ In cases dependent on hepatic disease Verneuil has found benefit from large blisters over the liver.

A lady, aged about sixty, whom I was called to see, had suffered from frequently-repeated attacks of hemorrhage from the right nostril for five days, for the last two of which it had been very severe. Astringent injections had failed to arrest it. On examining with a reflector and speculum and by the light of an ordinary paraffin lamp, after wiping with absorbent wool, blood was seen issuing from a small vessel at the anterior inferior part of the cartilaginous septum. The spot was carefully washed with strong solution of iron on wool, and a plug of the latter was inserted, not very tightly. There was no return of the hemorrhage.

From time to time, however, cases must be met with in which, from the violence of the hemorrhage or from the hidden position of its source, we are unable to find the bleeding point; and the less scientific method of plugging the nostrils must then be employed.

Plugging through the anterior nares, which is a comparatively simple procedure, may be done by packing small strips of lint into the nose with a probe until the front part of the cavity is completely filled up. Bosworth prefers pledgets of cotton packed tightly one on to the other into the nasal cavity. The first one, from one to one and a half inches long and of the diameter of a forefinger, should have a string attached to it and be passed with a fine pair of forceps to near the posterior nares. Iodoform gauze is recommended for this purpose by several observers,—Chiari, Baumgarten, Ingals, and Schulten. A kite-tailed tampon is advised by Moure, so that the plugs, being all attached to one string, can easily be removed.

Plugging the Posterior Nares.—The classical Bellocq's sound is usually recommended for passing the string through the nasal cavity, but by any one at all used to manipulating in the nasal cavity this may be readily accomplished without any special instrument. A piece of string, which for a distance of five or six inches from the end has been hardened by previous soaking in gum and drying, can generally be passed without difficulty through the nose till it shows below the palate. This is Wales's method, which I have found useful for introducing a string round the palate. If this plan fails, the thread can be passed through a Eustachian catheter or can be attached to the end of an ordinary gum catheter, and thus passed into the pharynx. In any case the string (which should consist of strong silk or whip-cord) is seized through the mouth with long forceps and drawn out. A plug of lint or cotton-wool about the size of a thumb (Spencer Watson) or of a walnut (Moldenhauer) is attached to the centre of the thread, and the plug drawn up close to the choana, its adjustment, if necessary, being assisted by means of a finger in the naso-pharynx. The anterior nasal orifice is then plugged with lint or cotton-wool, and the strings are tied together and either passed over the ear or fastened with strapping. Morell Mackenzie advises that the pharyngeal string should be cut off, allowing only a small piece of it to hang into the pharynx to facilitate the removal of the plug. In this case the thread may be used double, the two anterior ends being tied together over the anterior nasal plug. The post-nasal plug should not be

allowed to remain in position for more than twenty-four or forty-eight hours, as cases of septicæmia have been recorded from its being left in longer. It is best to insert the post-nasal plug dry, and not to saturate it with any styptic liquid.

Various india-rubber bags (termed *rhinobyons* and *rhineurynters*) which are inflated after insertion into the nostril are recommended by several authors, but have not come into general use.

Plugging is, of course, applicable only to intra-nasal hemorrhage; when it is of naso-pharyngeal origin we can trust only to the local application of astringents and the galvanic cautery.

Constitutional remedies have also been employed in epistaxis. The most commonly recommended are tannic and gallic acids, acetate of lead and sulphuric acid, iron, ergot, hamamelis, antipyrin, and opium; but it must be distinctly understood that the use of these is in no way to interfere with the employment of local remedies in conjunction with a thorough rhinoscopic examination, the latter being of paramount importance in the treatment of every case of epistaxis.

DISEASES OF THE ACCESSORY SINUSES OF THE NOSE.

BY JOSEPH H. BRYAN, M.D.,

Late Passed Assistant Surgeon United States Navy; Surgeon to the Throat Department
of the Garfield Memorial Hospital; Fellow of the American Laryngological
Association, etc., Washington, D.C.

By the term accessory or adjacent cavities of the nose is understood a number of pneumatic extensions into the bones of the head and face that communicate with the nose by means of one or more small openings. They are the maxillary sinuses, or the antra of Highmore, the ethmoidal sinuses, the frontal sinuses, and the sphenoidal sinuses.

I. DISEASES OF THE MAXILLARY SINUSES.

The antrum is the largest of the accessory cavities and the most important from a pathological stand-point, as it is by far the most frequently affected. Situated as it is between the teeth on one side and the nose on the other, with which latter cavity it is in direct communication by means of its natural openings, it is liable to be affected by pathological changes which may extend from one or the other source. The antrum is frequently the seat of an acute catarrhal inflammation, complicating an acute rhinitis, which usually undergoes resolution as soon as the inflammation in the nose subsides. It is generally not accompanied by any positive symptoms, save a sense of uneasiness, which may become actual pain if its secretions find any obstruction to their exit, and a discharge of a thick, yellow, gelatinous mucus. If, however, after the subsidence of the rhinitis, the inflammation in the antrum becomes chronic and the secretions are retained, there is established a condition known as

MUCOCELE.

Under the term *hydrops antri* was formerly described an affection characterized by an accumulation of a serous fluid in the antral cavity, containing cholesterin, and accompanied by a distention of the anterior walls of the sinus. These were, in all probability, cases of dentigerous cysts. *Hydrops* of this cavity in its true sense—that is, an inflammation characterized by a serous secretion—does not exist, and the term should be dropped from our list of diseases, as misleading. *Mucocele*, on the other hand, indi-

cates an accumulation of mucus in the sinus, the result of a catarrhal inflammation of the mucous membrane resulting from an extension of the inflammation from the nose, and where the ostium maxillare becomes closed so that the pent-up mucus cannot escape. The subjective symptoms are a peculiar dull pain which is not localized, but which extends over the affected side of the face, and occasionally pain in the teeth. The objective symptoms are a swelling of the face and a bulging of the canine fossa; the soft parts covering the bone become red and slightly œdematous. If the collection of mucus is not evacuated, or if the intensity of the inflammation increases, a suppurative inflammation results, and we find then the condition known as

EMPHYEMA OF THE MAXILLARY SINUS.

This is a much more common affection than mucocœle. Until within recent years abscess of the antrum was regarded as rather an uncommon disease, but, owing to the marked advances that have been made in the study of diseases of the nose within the last ten years, it is now much more frequently observed than formerly.

Etiology.—This cavity is especially liable to be attacked from one of two sources,—either from an extension of an inflammation of a tooth, or from some diseased condition of the nose.

Authorities are not in accord as to the most common source. Christopher Heath, Semon, Fränkel, Moritz Schmidt, and Kuchenbecker assert that disease of the teeth is the most common source of the affection; while on the other hand, in the experience of equally competent observers, as Zuckerkandl, Krause, Hartmann, Ziem, Bronner, MacDonald, and Bosworth, it has in the majority of instances resulted from disease of the nasal cavities. It is difficult to account for this discrepancy of opinion. In my own experience diseases of the teeth have been by far the most common cause. Kuchenbecker¹ found, out of thirty-one cases, thirty-three per cent. the result of dental caries, twenty-two per cent. due to general diseases, ten per cent. to tumors, twenty-two per cent. to unknown causes, while only thirteen per cent. could be traced to nasal origin. The teeth most frequently at fault are the first and second molars, and occasionally, when the antrum is unusually developed, the roots of the first and second bicuspid teeth are brought into close relationship with its floor, and any pathological changes taking place in them can be readily transferred to that cavity. While this affection usually occurs after the second dentition, it has been observed prior to this period, as is illustrated in the case of a child, eight years of age, observed by P. D. Pedley,² where the abscess resulted from caries of a temporary canine tooth. All morbid conditions of the teeth and gums can be regarded as exciting causes of empyema. It sometimes happens that a suppurative inflammation of the antrum is excited by a

¹ Monatschrift für Ohrenheilkunde, 1892, No. 3.

² London Lancet, February 16, 1889.

tooth which, in the course of extraction, has been pushed into the cavity, or by a fracture of the alveoli occurring in the course of extraction. Occasionally, as observed by Wyeth,¹ a supernumerary tooth is found in the sinus, and, acting as a foreign body, causes inflammation of the lining membrane.

Zuckerkandl² is of the opinion that the most frequent cause of this disease is the extension of the inflammatory process from the nose into the cavity. Bosworth³ dissents from this view, believing that the disease rarely results from an extension of the inflammation through the continuity of tissue, but is due rather to a catarrhal inflammation of the mucous membrane of the sinus, brought about by a closure of the ostium maxillare, and which eventually degenerates into one characterized by a purulent discharge. In this manner hypertrophic rhinitis and polypi producing stenosis of the natural opening frequently cause a suppurative inflammation of the antrum. According to Kuchenbecker,⁴ the use of the galvano-cautery in the nose has been followed by an abscess in this cavity. Aside from the above-mentioned causes may be mentioned the acute infectious diseases, as measles, scarlet fever, and small-pox; also scrofula, syphilis, and traumatism. Watson⁵ cites two cases in children where the disease was supposed to have been the result of injuries received during parturition, and it has also followed Malgaigne's operation for division of the infra-orbital nerve.

Symptoms.—The symptoms vary according to the exciting cause and to the open or closed condition of the ostium maxillare. If the opening is free there will be a purulent discharge from one side of the nose; only in rare instances where both cavities are affected is it bilateral. Lichtwitz,⁶ however, has recently shown that double empyema of the maxillary sinuses is much more common than is generally supposed. In thirty-one cases he made forty-three punctures through the inferior meatus and found double abscess of the antrum in twelve cases. Occasionally the flow of pus is continuous, but frequently it is periodical, the discharge depending a good deal upon the condition of the parts around the opening, whether there is hypertrophy of the turbinals, or whether polypi are present, and upon the position of the patient's head. In the erect position there is a slight discharge, which is increased when the head is bent forward or backward.

Upon inspection pus will be found in the middle meatus and flowing over the anterior extremity of the middle turbinated body; but in case it meets with any obstruction, as from hypertrophies of the turbinals or from polypi, the pus works its way backward and the patient complains of a constant dropping of a foul secretion into the throat. The secretion is generally fetid, its odor being especially perceptible to the patient, and in

¹ New York Medical Record, December 8, 1883, p. 633.

² Normale und Pathologische Anatomie der Nasenhöhle, Band i. p. 137.

³ Diseases of the Nose and Naso-Pharynx, New York, 1889, p. 466.

⁴ Monatsschrift für Ohrenheilkunde, 1892, No. 3.

⁵ Diseases of the Nose, London, 2d ed.

⁶ Prager Medicinische Wochenschrift, No. 15, 1892.

this respect this affection is in marked contrast to that condition known as *ozæna*, or atrophic rhinitis, with which it has been confounded, where the fetor of the secretions is imperceptible to the patient but very noticeable to his friends. The character of the discharge varies from a thick mucopurulent to a thin purulent secretion, and in rare instances, where there is caries of the walls of the cavity or of the alveolar process, the secretion may be caseous.

In a case that recently came under my observation, where the inflammation was caused by breaking a needle off in the tooth, the secretions were found to be composed of pus mixed with dark grumous blood. Upon extracting the tooth the needle was found to project about an eighth of an inch beyond the apex of its root into the cavity, and was very much corroded. The abscess had existed for six and possibly seven years. Pain is complained of usually in various parts of the cheek and at the root of the nose, but it is not constant, and frequently it is absent entirely, the patient complaining only of an uncomfortable feeling in the cheek. Painful sensations may sometimes be excited by firm pressure over the anterior wall and in the canine fossa. Upon examining the nose, if the middle meatus is full of pus, a pulsating light-reflex is occasionally observed similar to that seen in perforations of the *membrana tympani* during acute suppurative otitis media. This symptom was first pointed out by Walb and Schöller, and I have met with it in several instances. When present it is regarded as a pathognomonic symptom of abscess of the maxillary sinus.

It is rarely the case that the whole list of subjective and objective symptoms are present; frequently the only symptom the patient complains of is the unilateral discharge of pus from the nose. If the opening is closed the symptoms become very much more decided; a dull aching pain is felt in the jaw, not localized, but radiating up to the orbit and frontal region and along the alveolar process. The teeth on the affected side seem to be longer than usual, and there is some swelling of the soft parts covering the anterior wall of the affected cavity. The nasal wall of the sinus about the middle meatus bulges inward and frequently interferes with nasal respiration. This symptom is more frequently present than is generally supposed. Hartmann has observed it in about one-half of his cases. If the distention is sufficiently great to cause pressure of the upper wall or the floor of the orbit upward, there may be *exophthalmus*, and a narrowing of the field of vision. These, however, are exceedingly rare symptoms in abscess of the antrum. In a few instances the patient complains of a bad odor to the breath, without any discharge, but careful questioning will generally elicit the fact that at some previous time there had been a profuse discharge from one side of the nose. In these cases the abscess is latent; the watery constituents having evaporated, there remains a thick, fetid, purulent secretion on the floor of the antrum, too thick to be discharged through the opening into the nose, but still emitting this foul odor, which is the only symptom that attracts the patient's attention.

In all cases where there has been a continuous discharge for a number of years there is nearly always a marked disturbance of the general health. The patients are anæmic, frequently emaciated, and complain of constant nausea and loss of appetite. There is frequently great depression of the spirits, sometimes bordering on melancholia, and they shun society, fearing that the odor will be perceptible to their friends. When the symptoms are obscure they are often assigned to hypochondria and hysteria. When lying down at night the patient is frequently troubled with an obstinate cough, as in Front's¹ cases. The most frequent complications of abscess of the antrum are hypertrophy of the turbinated bodies and mucous polypi, which may be primary and the cause of the antral inflammation. In other instances, however, they are secondary to the inflammation in the sinus caused by the irritating pus flowing into the nose. Occasionally the inflammation extends into the ethmoidal, frontal, and sphenoidal sinuses, giving rise to abscesses, and may finally involve the brain. Among the eye-complications which have been observed are acute and chronic conjunctivitis, panophthalmitis, exophthalmus, a narrowing of the field of vision, and orbital abscess. Kuchenbecker² reports a case of otitis media complicating an abscess of the antrum.

Diagnosis.—In well-marked cases the diagnosis of abscess of the antrum is not attended with much difficulty; but the typical cases are not the rule, and, as there are frequently one or more complications present to obscure the general symptoms, the surgeon will occasionally find some difficulty in making a positive diagnosis. A constant or an intermittent unilateral discharge of pus from the nose should always suggest a suppurative inflammation in one of the accessory cavities. The pus in antrum inflammation is nearly always of a bright-yellow color and varying from a thick colloid to a thin watery consistency. Upon examining the nose the tissues should be contracted by means of a four-per-cent. solution of cocaine, when pus will be found in the middle meatus, and if in sufficient quantity to fill that passage, a pulsating light-reflex will be observed. If the pus be wiped away with a pledget of absorbent cotton, it will rapidly reappear, and will be observed to make its appearance from beneath the middle turbinated body about the middle of the meatus. Hartmann, of Berlin, recommends that after thoroughly removing the secretion from the meatus a strong current of air should be blown through the nose with a Politzer air-bag. By this means the pus is drawn out of the cavity into the meatus, and its source is thus readily recognized. This is applicable to those cases in which the pus does not flow readily from the cavity into the nose. There is, however, some objection to this procedure, owing to the danger of driving pus through the Eustachian tube into the middle ear. Ziem overcomes this objection by using a curved-nozzled syringe and blowing through

¹ North Carolina Medical Journal, January, 1887.

² Monatsschrift für Ohrenheilkunde, No. 3, 1892.

the posterior nares. It should be resorted to only after the nose and post-nasal space have been thoroughly cleansed by means of a spray. The position of the head will sometimes enable us to determine the source of the pus, and Fränkel¹ directs that after all visible pus has been removed from the nasal cavity the head should be lowered between the knees for a few minutes, at the same time rotating it somewhat so that the suspected cavity is uppermost. If upon re-inspection of the nose, after raising the head, pus is observed in the middle meatus, the probabilities are that it comes from the maxillary sinus.

In those cases in which the pus does not find a ready entrance into the nose, owing to a narrowing or closure of the ostium maxillare, Hansberg² has recommended that the opening be enlarged by the passage of a sound into the sinus. He uses a small probe fifteen centimetres in length and about one and one-fourth millimetres in thickness, bent at six millimetres from its tip at an angle of 110° , and with good illumination, the part having been thoroughly anæsthetized by means of cocaine, the probe is introduced into the middle meatus and the opening searched for. Entrance into the cavity is readily recognized by the resistance offered to the to-and-fro movements of the probe. Pus, if present in the cavity in sufficient quantity, will readily find its way into the middle meatus upon the withdrawal of the instrument. It frequently happens that at the time of the examination there is not enough pus in the cavity for it to flow out into the nose, in which case its presence can be detected by the injection through the opening of a small quantity of the peroxide of hydrogen into the cavity by means of a very fine-nozzled syringe. If pus is present in the sinus in the smallest quantity, the middle meatus and nasal chamber will be filled with the white foam characteristic of the action of the peroxide of hydrogen on pus. This is a valuable test when it can be carried out, but, owing to the fact that the entrance to the ostium maxillare is frequently obstructed by an overhanging hypertrophied middle turbinated body, it is sometimes impossible to reach it with a syringe.

Percussion is sometimes useful in eliciting dulness on the affected side. Tapping a tooth under the suspected cavity, as suggested by Watson, will often elicit a sensitiveness which indicates that there is some active process going on at its roots, and an examination of the alveolar process with the finger will reveal an enlargement over the seat of a diseased tooth. This, in conjunction with other symptoms, would indicate antral inflammation of dental origin. Moritz Schmidt³ has suggested the most positive means of determining the presence of pus in the antrum,—that is, the aspiration of the sinus through the lateral wall of the nose; he advises that in all doubtful cases the cavity should be punctured by means of a strong curved aspirating-needle through the inferior meatus. As the bone is generally quite

¹ Berliner Klinische Wochenschrift, 1877, No. 16, p. 273.

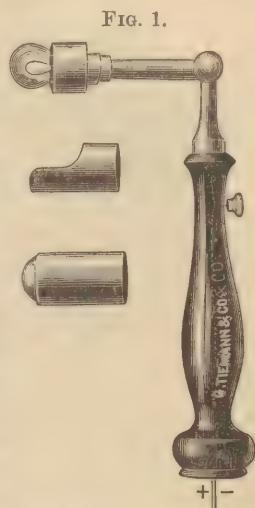
² Monatsschrift für Ohrenheilkunde, June, 1893.

³ Berliner Klinische Wochenschrift, December 10, 1888.

thick at this point, it is better to make the puncture through the middle meatus, where the wall is made up of very thin bone or membrane, the parts having been first thoroughly anæsthetized with a twenty-per-cent. solution of cocaine. Care should be observed to pass the needle from above downward and outward, so as not by any possible means to wound the floor of the orbit. If pus be present in the cavity it can readily be drawn off. The principal objection to this procedure is that the bony wall is sometimes quite thick, and its puncture is attended with considerable pain in spite of the cocaine.

A further aid to the diagnosis was recently added by the late and lamented Voltolini, who, adopting the suggestion of Czermak for examining the larynx by transmitted light, made use of the principle of trans-illumination in the diagnosis of thickening of the *alæ* of the thyroid cartilage in cases of perichondritis of the larynx, and he applied the same method to the examination of the bones of the face, and found in those cases in which there was not undue thickness of the bones that they transmitted light. The method has been perfected by Heryng¹ and Vohsen.² Heryng originally used an instrument consisting of a five-volt electric lamp attached to a Türek's tongue-depressor. He has recently improved the lamp so that it can be used for examining not only the antrum, but also the frontal sinuses and the larynx. The improved instrument is well illustrated in Fig. 1. The method of employing the lamp is as follows. The instrument with the mouth-tip attached is introduced into the mouth, and the patient directed to close the lips firmly, the room having been previously made as dark as possible; the circuit of the current is now completed, and immediately the cavities, if in a state of health, are illuminated as high as the infra-orbital ridge. In case pus or a solid tumor be present in the antrum, that side of the face remains dark, while the opposite is brightly illuminated. In the case of cysts of the sinus it becomes much more brilliantly illuminated than the opposite side. Voltolini was thus enabled to differentiate between a cyst and a supposed sarcoma in a case which was destined to excision of the superior maxilla.

Unfortunately, the illumination of the antrum by means of the electric light, which it was thought at first would prove a positive aid to the diagnosis, has proved disappointing and misleading in a number of cases. It occasionally happens when there is only a very small quantity of pus in the



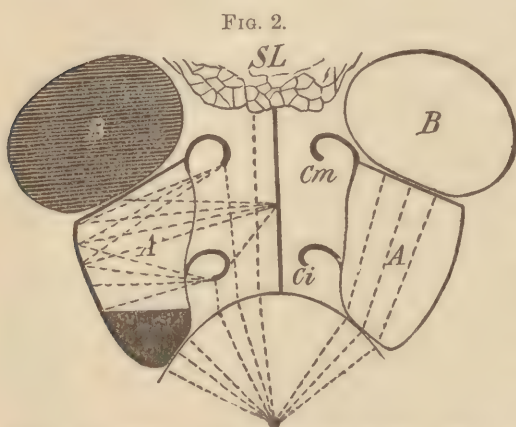
Heryng's improved electric lamp.

¹ Berliner Klinische Wochenschrift, 1889, No. 39.

² Ibid., 1890, No. 12.

sinus that there is no perceptible difference in the illumination of the two sides of the face, as is illustrated by the cases of Lichtwitz and Srebný,¹ who found pus in the antrum notwithstanding it was illuminated. The cause of the discrepancy will be readily understood by reading the lucid explanation given in a recent article by Davidsohn,² who places less reliance on the illumination of the maxillary sinus and more on the illumination of the eye as a diagnostic aid in abscess of this cavity. He makes the very positive statement that the illumination of the eye is the only certain sign that we have in the diagnosis of abscess of the antrum. By reference to Fig. 2, borrowed from his article, it will be readily understood how, in the case of

an antrum in the state of health, the eye will be illuminated, whereas if the sinus on the opposite side should contain a small quantity of pus the cavity itself may be illuminated by the rays of light being deflected from the turbinated bodies and irregularities of the septum into the cavity above the level of the secretion, while the corresponding eye remains dark. While an illuminated eye is always the sign of a



B, eye; *A*, antrum; *Ci*, inferior turbinated body; *Cm*, middle turbinated body; *SL*, ethmoid cells. (Davidsohn.)

healthy antrum, it does not necessarily follow that a dark eye signifies a disease of that cavity, for there are various conditions which might prevent the eye from being illuminated, such as undue narrowing of the antral cavity, a state of asymmetry of the hard palate, or an excessively high arched palate, where the rays of light, instead of passing through the sinus, enter the nasal chambers.

Prognosis.—Although seldom fatal except in those rare instances where the inflammation has extended through the neighboring sinuses to the cranial cavity, and death results either from meningitis or from cerebral abscess, it is nevertheless an exceedingly difficult affection to cure. Spontaneous resolution has been observed in only a few cases. The duration depends largely upon the etiology, the length of time the abscess has existed, and whether caries or necrosis is present.

Treatment.—Acute catarrhal inflammation of the antrum occurring in the course of an acute rhinitis requires no special treatment, as it usually subsides as the inflammation in the nose undergoes resolution. If there

¹ Berliner Klinische Wochenschrift, 1890, No. 46.

² Ibid., 1892, Nos. 27 and 28.

should be much pain due to a closure of the ostium maxillare, a pledget of cotton saturated with a twenty-per-cent. solution of cocaine will have the effect of opening it, when the nose should be inflated with a Politzer air-bag. The opening must be kept free by the use of detergent sprays until all signs of inflammation have ceased. The indications for the treatment of mucocele are the same as for the treatment of abscess of the antrum. They are perfectly painless, and necessitate opening the cavity and establishing free drainage until all discharge of mucus or of pus has ceased. If the disease appears in the course of intra-nasal disease, such as polypi or hypertrophic rhinitis, these conditions should be thoroughly removed, so that the ostium maxillare can be kept open and the sinus drained through the nose. The nasal cavity should be sprayed several times a day with mild alkaline solutions.

The method of treating suppurative inflammation of the antrum has of late given rise to considerable divergence of opinion, almost as much so as the etiology, the development of rhinology causing a tendency on the part of modern surgeons to treat the cavity through the nose. The method so strongly recommended by Hartmann, Störk, and others, of treating abscess of this sinus by washing out and injecting antiseptic solutions through the natural opening in the middle meatus, is not only a difficult and painful procedure to carry out, owing to the difficulty in finding the opening, but it is also very slow and unsatisfactory as to the results. In order to facilitate finding the opening into the sinus, it has been proposed by Michel and Heryng to remove the middle turbinated body, either wholly or in part.

The operative treatment consists in making an opening into the cavity and washing it out daily until all suppuration has ceased. The older surgeons devoted a great deal of attention to the operations for opening the antrum of Highmore. It was at a time when they were busy studying its anatomy and physiology. Dieffenbach, in his *System of Surgery*, says they gave a much more prominent place in their works to these operations than they deserved, more space being allotted to them than was given to resection of the jaw. Among the earlier methods for opening this cavity was that proposed by Molinetti, who in 1675 opened the maxillary sinus by making a crucial incision in the cheek and then perforating through the canine fossa into the cavity. The operation naturally found few followers.

All our present methods are derived from the surgeons of the latter part of the eighteenth century. It was about this period that Cooper opened the antrum through the mouth by extracting a tooth and entering a cavity through the empty alveolus. If there is a carious molar tooth present, which in the majority of cases is the cause of the inflammation, it should be extracted. Frequently the cavity will be opened by this procedure; if not, then it will be necessary to establish communication with it by means of a strong trocar, or, which is much safer and much more satisfactory, by means of a small trephine propelled by a surgical engine or

an electric motor. This instrument should be directed slightly forward and inward, in order to penetrate the cavity at its most dependent part, and upon the withdrawal of the instrument it will be followed by a discharge of pus into the mouth.

The advantages of this operation are that not infrequently the cause of the trouble is removed by extracting the tooth, and, as the cavity is perforated at its most dependent part, perfect drainage can take place and the cleansing applications be thoroughly made. This is done by syringing through the opening until the solution comes away from the nose perfectly clear. It is necessary to employ a strong stream in washing out the cavity, for only by so doing is it possible to cleanse all the recesses in the sinus formed by the little bony septa on its floor, which are sometimes so developed as to form almost independent cavities. In order to prevent the opening from closing it is best to insert a small metallic perforated drainage-tube; a tube similar to the Knapp mastoid drainage-tube, except that it should have a large flange, will answer the purpose very well. It can be kept closed with a small conical rubber plug, so that the patient will not be annoyed by the secretions constantly passing into the mouth. A rubber drainage-tube should not be used, on account of the danger of its passing into the cavity. Owing to the slow development of the maxillary sinus, the alveolar operation is not to be thought of in children.

If for any reason it is not desirable to extract the tooth, or if the anterior wall should show signs of weakening and bulge forward in the canine fossa, the cavity can be opened at this point, a small piece of bone being resected from the fossa, as recommended by Desault. Occasionally, when in old and neglected cases the abscess has caused weakening of the hard palate and shows a tendency to discharge into the mouth, the cavity can be perforated at this point, as suggested by Bertrandi; but under other circumstances the method is not desirable.

Within the last few years, with the rapid development of rhinology, it has been proposed by some surgeons to abandon the older operations through the mouth (especially in cases of nasal origin, on account of the danger of food and bacteria from the mouth getting into the sinus and keeping up the suppuration, and as it obviates the necessity of sacrificing a sound tooth), and to return to the method of opening the sinus through the nose, as originally proposed by John Hunter and practised by Jourdain, who opened the cavity through the infundibulum in the middle meatus. Owing to the high point selected for making the artificial opening into the antrum, drainage cannot take place readily, and there is danger of wounding the floor of the orbit.

If for any reason it is desirable to enter the cavity through the nose, the method proposed by Mikulicz in 1887, or some modification of it, should be adopted. Mikulicz¹ advised opening the sinus through the

¹ Archiv für Klinische Chirurgie, Berlin, 1887, p. 626.

inferior meatus with an instrument specially constructed for that purpose, which consists of a spear-shaped knife mounted on a shaft, curved at a right angle, and having a projecting flange to regulate the depth of the cut. This instrument is introduced into the nasal chamber with its point towards the floor, and when at a point just under the natural opening of the sinus into the nose, the instrument is turned and the knife forced through the inferior meatus into the sinus. A large triangular opening is thus established, sufficiently near the floor of the cavity to permit of easy drainage and the ready application of antiseptic lotions.

Owing to the troublesome hemorrhage, which is sometimes quite severe after the use of this instrument, it is better to make the opening into the cavity either with the instrument of Krause, which consists of a strong curved trocar and canula, or by means of the antrum drill of J. Solis Cohen. (Fig. 3.) It consists of an olive-pointed burr attached to a small stem encased in a canula sufficiently large to admit of the withdrawal of

FIG. 3.



Cohen's antrum drill.

the burr after the cavity has been penetrated. The canula can then be left in the opening until the sinus has been thoroughly washed out. This instrument is propelled by the surgical engine, the electric motor, or the hand. The great advantage of this proceeding over that of Mikulicz is that the resulting opening is not so large and the hemorrhage not so great, while at the same time it penetrates the sinus sufficiently near its floor to secure perfect drainage. The sinus can be washed out daily by the introduction of the canula or a fine Eustachian catheter into the opening.

Franz Block,¹ who opens this cavity through the inferior meatus by means of a fine lance-pointed trocar, employs a double catheter-beaked canula in washing out the cavity, so as to provide for flushing it by reflux in case the normal opening in the middle meatus should be clogged. When the cavity is first opened it should be thoroughly explored with the probe, in order to detect any necrosis that may be present, the presence of a supernumerary tooth, or bony septa that may be thrown across the cavity. The intra-nasal method of penetrating the maxillary sinus has the disadvantage that it is not practicable in cases of abnormally small nasal chambers, nor when there is a deflection of the septum towards the affected cavity; also in that the daily irrigation must be conducted by the surgeon, while in the alveolar operation this can generally be done by the patient.

¹ Münchener Medicinische Wochenschrift, 1891, No. 34.

The local treatment is very important, and on the care and thoroughness with which this is conducted frequently depends the successful issue of the case. The cavity should be irrigated with a warm saturated solution of boric acid until all reaction has subsided. If there is much fetor, which is almost invariably the case, it can be best overcome by employing a solution of permanganate of potassium. Two or three such irrigations will generally suffice to destroy the odor. The cavity should then be syringed out with a fifteen-volume solution of the peroxide of hydrogen, diluted about one-half to commence with, and finally used in its full strength. This will be found to be a most valuable application in many cases, and if the case progresses favorably the secretion of pus diminishes gradually until within two or three weeks it ceases entirely. If, for any reason, the peroxide of hydrogen is not well borne by the patient, a solution of carbolic acid (thirty grains) and common table salt (about sixty grains to eight ounces of water) will be found a very efficient substitute. The application of strong solutions of nitrate of silver and chloride of zinc cannot be too positively condemned.

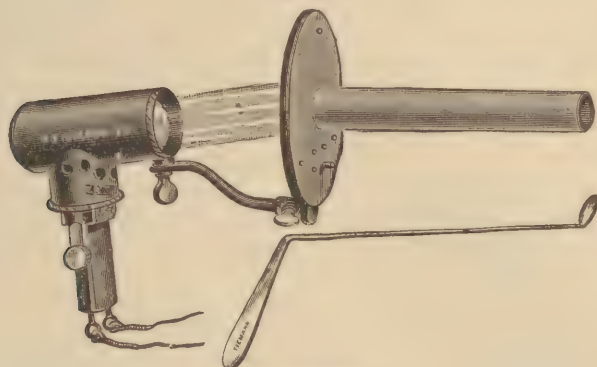
When the case does not terminate so favorably, the dry treatment, as suggested by Friedländer,¹ should be tried. The cavity is first thoroughly washed out with a strong stream of water and then dried thoroughly by means of air blown into the cavity with a Politzer air-bag, after which iodoform is insufflated. This method of treatment has been successful in reducing the inflammation in a very short space of time, but occasionally cases are met with in which the secretion of pus continues in spite of the most careful and persistent treatment. In these cases Krause recommends that the opening into the sinus, either through the canine fossa or through the alveolar process, should be enlarged sufficiently to admit of the little finger being passed into the antral cavity and a thorough exploration being made. Any bony partitions or sharp bony projections, or a supernumerary tooth that may be present, must be removed. The cavity should then be washed out thoroughly with an antiseptic solution and packed with iodoform gauze.

While the impression received by the introduction of the probe or finger into the sinus will reveal certain conditions that serve to keep up the inflammation, such as bony partitions that may be thrown out across the cavity, rough bone due to caries and necrosis, or the presence of an extra tooth, there are other conditions of the lining membrane of this cavity that cannot be recognized by this method of examination, such as cystic degeneration, ulcers, fungoid granulations, polypi, and other tumors which have not reached an advanced stage of development. Any instrument that will enable us to make an inspection of the interior of the cavity will greatly aid the surgeon in ascertaining the cause of the continued suppuration, and will enable him to decide upon the nature of the further operative measures

¹ Berliner Klinische Wochenschrift, 1889, No. 37.

that may be necessary to bring about an ultimate cure. Such an instrument, I believe, we have in the ingenious endoscope recently devised by Dr. William K. Otis, of New York. It consists, as will be seen in Fig. 4, of

FIG. 4.



The antroscope.

an electric lamp (seven volts) from which the rays of light are conducted through the tube connected with the diaphragm. For use in the antrum, the tube has been made shorter and of a much smaller calibre than in the instrument as originally constructed. To this is added a small highly-polished metallic mirror, bent at such an angle that, when introduced into the sinus and rotated, the whole of the interior of the cavity can be brought into view. Judging alone from the facility with which the interior of the maxillary sinus can be inspected in the cadaver, I am led to believe that it may have some practical application upon the living subject, and that it will throw some light upon the cause of the prolonged suppuration in obstinate cases of abscess of the antrum. The tube can be introduced either through an opening in the canine fossa or through the alveolar process.

DIPHTHERIA OF THE ANTRUM.

This is a rare form of inflammation affecting the mucous membrane of the maxillary sinus, and it can only take place as an extension of a diphtheritic inflammation of the nose. The appearances, however, are not the same: while in the nose there is a membranous deposit, no deposit takes place in the antrum, the membrane being red, swollen, and ecchymotic in places.

PHLEGMONOUS INFLAMMATION OF THE ANTRUM.

This is even more rare than diphtheria of this cavity. It is characterized as an inflammation of the lining membrane of the cavity, with confluent or disseminating deposits which undergo fibrinous degeneration. It is either primary or secondary to phlegmonous inflammation of the tongue or pharynx, and to laryngeal and pharyngeal croup. It generally proves

fatal in from two to four days. The symptoms are generally very severe: high fever with intense pain in the region of the maxillary sinus.

ERYSIPELAS OF THE ANTRUM.

Luc¹ has recently reported a case of erysipelas of the antrum, secondary to facial erysipelas, in a man sixty-one years of age, during the course of which empyema developed. Upon examining the pus, the streptococci of erysipelas were found. In the course of treatment the patient had a severe attack of erysipelas starting from the nose.

TUBERCULOSIS OF THE ANTRUM.

This affection has been observed once by Neumann² in a case of caries of the superior maxilla, in which the maxillary sinus contained granulations filled with tubercles.

TUMORS OF THE ANTRUM.

The maxillary sinus is sometimes the seat of tumor-formation, which may be either benign or malignant. The most frequent form of tumor met with in this cavity is the myxomatous polyp. It is not of very frequent occurrence, for Zuckerkandl, in three hundred post-mortem examinations, discovered it in only six instances. This author divides polypi of the antrum into three varieties: the typical pedunculated polypus, a bridge-like formation extending across the cavity between its two walls, and the flat variety, which seems to be nothing more than an hypertrophy of the mucous membrane which forms its base. They sometimes extend into the nasal cavity, and are very vascular, bleeding freely when interfered with. Occasionally they are forerunners of malignant disease.

Symptoms.—Isolated polypi, when confined to this cavity, seldom give rise to any symptoms by which their presence can be detected: so it often happens that they are discovered only on post-mortem examination. If, however, they are numerous and undergo a cystic degeneration, they cause a distention of the walls of the cavity and give rise to a muco-purulent discharge from the nose which may be mistaken for abscess of the antrum.

The treatment consists in extirpation through an opening made into the anterior wall of the sinus.

CYSTS OF THE ANTRUM.

Cystic formations in the antrum may be of three varieties: those which are due to a dilatation of the follicles in the mucous membrane lining the cavity, polypi which have undergone cystic degeneration, and dentigerous cysts. They may be either single or multiple, and sometimes the entire mucous membrane seems to have undergone a cystic degeneration. Of the dentigerous cysts there are two varieties. The internal variety arises from the roots of a tooth, generally in the course of an inflammation, and

¹ Deutsche Medicinische Wochenschrift, 1892, No. 81.

² Cited by Scheech.

develops within the cavity of the antrum. It may be connected either with a fully- or an imperfectly-developed tooth. The external variety develops without the antral cavity, and by gradual growth increases to such a size that it is frequently mistaken for the maxillary sinus. Such a case is illustrated by Zuckerkandl, and will be seen in Fig. 5, in which it will be observed that the cyst has encroached upon the antral cavity to such an extent as almost to obliterate it, while it is still separated from that cavity by a very thin lamella of bone which has not undergone absorption.

Symptoms.—These cysts are generally of slow development, their growth is not accompanied by any pain, and they give rise to no trouble until the distortion of the face commences. They continue to increase in size until the bony walls become thin, when on pressure with the finger there will be a crepitating sensation produced, which is a characteristic symptom of a dentigerous cyst. When the bone between the antrum and the cyst-cavity has been absorbed, the sac may rupture and its contents be discharged through the antrum into the nose, giving rise to symptoms of abscess of the antrum.

Diagnosis.—It is very difficult to differentiate between an external dentigerous cyst and one that originates within the sinus, and at times it is impossible until an exploratory incision has been made.

It is frequently mistaken for a solid tumor which has originated within the cavity; but with the electric light the cavity would be translucent in the case of a cyst, while if a solid tumor were present it would remain opaque. If doubt still exist, the cavity should be aspirated, when, if it be a case of cyst, a dark clear fluid will escape which may contain pus if there has been any active inflammation present.

Treatment.—The treatment consists in cutting away the outer wall of the cavity, breaking down any bony partitions that may have formed, and packing the cavity with iodoform gauze until healing has taken place.

Carcinomata, etc.—Among the other forms of tumor met with in the antrum may be mentioned the erectile or cavernous, fibrous, fibro-sarcomatous, osteo-sarcomatous, recurrent fibroid, medullary sarcomatous, myeloid, osseous, and carcinomatous. The solid tumors of the antrum show a tendency to break through into the nose, into the orbit, and into the mouth.

Treatment.—The treatment of these growths consists in extirpation, or in partial or total resection of the jaw.

FIG. 5.



A large cyst of the superior maxilla encroaching upon and narrowing to a great degree the maxillary sinus. (Zuckerkandl.)

II. DISEASES OF THE ETHMOIDAL SINUSES.

In the order of frequency of occurrence diseases of the ethmoid cells probably come next to those of the maxillary sinus. They occur partly alone and partly in conjunction with diseases of the other accessory cavities. As in the case of the maxillary sinus, the ethmoid cells are frequently affected by an extension of the inflammation from an acute rhinitis, producing a catarrhal inflammation of the mucous-membrane lining of the cells. Such inflammations may be either acute or chronic. Occurring in the course of an acute rhinitis, the symptoms of this disease are marked by an intense pain over the bridge and at the root of the nose, extending to the frontal region and along the infra-orbital ridge. While an acute catarrhal inflammation of the ethmoid sinus is not a serious affection, and generally subsides spontaneously, it may, on the other hand, become chronic, the secretions changing, becoming purulent and hemorrhagic in character, thus resulting in abscess of the cells, which is an exceedingly dangerous disease.

Etiology.—Suppuration of the ethmoid cells most frequently occurs in the course of a catarrhal rhinitis, which may be either acute or chronic. Occasionally it has been observed in conjunction with facial erysipelas, the inflammatory process having extended through the nose to the cells; but Zuckerkandl believes that in these cases the inflammation in the nose may be the cause of the facial erysipelas. Weichselbaum¹ has observed it to be the cause of suppuration of the cells in three out of ten cases. On the other hand, the inflammation can extend into the cells through the orbit, or from the adjacent cavities, such as in the case of the sphenoidal cells, which sometimes communicate directly with the posterior ethmoid cells, from the maxillary sinus, or from the frontal sinus, as in a case observed by Knapp. It may occur also in consequence of the closure of the ostium ethmoidale, either through a swelling or hypertrophy of the middle turbinated body, or through a closure of the opening by means of a mucous polyp. Owing to the peculiar character of the membrane lining the ethmoid cells, which fills the double office of mucous membrane and periosteum, it is sometimes very difficult to draw the line between a simple suppurative inflammation of the membrane and disease of the bone itself. Probably in every severe inflammation of the cells the periosteal layer of the membrane is affected, and it is frequently followed by caries and necrosis of the ethmoid bone. Workers in phosphorus are subject to necrosis of the bones of the face, and the ethmoid is liable to be affected among them. Scobell Savory² reports a case of a young man eighteen years of age, a worker in phosphorus, who

¹ Berger and Tyrmann, *Krankheiten der Keilbeinhöhle und Siebbein-Labyrinth*, p. 18.

² *Medico-Chirurgical Transactions*, 1874, vol. lvii. p. 187.

died from its effects, and upon the post-mortem examination all the bones of the face were necrosed, the ethmoid being almost completely destroyed. Among other causes of suppuration of the ethmoid cells may be mentioned caries and necrosis resulting from syphilis, serofula, and tuberculosis. There seems to be no doubt that the former affection is a frequent factor in the etiology of the disease.

Symptoms.—One of the earliest symptoms of abscess of the ethmoid cells is pain referred to the root of the nose, increasing in severity with the progress of the disease and extending outwardly along the infra-orbital ridge to the temporal region. With the distention of the cells the pain is referred to the orbit, especially back of the eye, and to the frontal region. A unilateral discharge of muco-pus sets in early, which is of a bright-yellow color. The fetor which is generally present is not so marked, and is not so annoying to the patient, as in the case of abscess of the antrum. This is owing to the absence of the sense of smell, which is lost in the early stages of the disease. In the latter stages, as soon as caries and necrosis take place the character of the secretion changes, and it becomes thicker and caseous, containing also small, gritty particles of broken-down bone. Generally there is an obstruction of the affected side of the nose, due to a swelling of the middle turbinated body, which may be so greatly swollen as to project against the septum. The flow of pus is usually constant, differing in this respect from abscess of the maxillary sinus. In very rare instances the disease runs its course symptomless, as in a case reported by Vermyne,¹ where the disease resulted from scarlet fever and was without a discharge of pus, but a tumor formed at the inner angle of the eye, which upon being opened was found to contain pus. With the distention of the cells from an accumulation of secretion there is a giving way on the side of the least resistance, which is towards the orbit; consequently, there is a bulging of the eye forward and outward, accompanied by such functional symptoms as narrowing of the field of vision, diplopia, and impairment of the vision. Exophthalmus, while not a constant symptom, is a significant one, and one that is frequently present. Pressure on the eyeball will cause the pus to be discharged more freely from the nose. Frequently there is a swelling at the inner angle of the orbit, and when pressure is made at this point a crepitating sensation is produced. Redness extending along the infra-orbital ridge, with a slight oedema of the skin, was present in several of my cases. The general health is nearly always affected, the patient being depressed mentally, and if the secretions pass into the post-nasal space there will be the morning nausea and loss of appetite so frequently met with in antral diseases. In some cases there is a marked elevation of temperature, accompanied by chills or chilly sensations.

Suppurating ethmoiditis is frequently complicated by abscess of the antrum, orbital and frontal abscess, and meningitis. The most frequent of

¹ American Journal of Ophthalmology, 1884, vol. i., No. 5, p. 129.

these complications is undoubtedly abscess of the antrum. Bosworth,¹ in thirteen cases of this affection, found the antrum was implicated in seven. The frequency of this complication is accounted for in several ways. 1. The opening of the anterior ethmoid cells and that of the antrum lie very close together, and inflammations of the nose affecting one cavity would be most likely to extend to the other. 2. Mechanical obstruction, either from polypi or hypertrophic rhinitis, causes the mucus to be confined in both sinuses, and a consequent purulent inflammation results. 3. Pus accumulates in the middle meatus and works its way into the maxillary sinus. 4. There is sometimes an anomalous condition of the ethmoid bone, in which the anterior and posterior ethmoid cells communicate directly with the antrum. The symptoms of this affection may be so masked by those of the ethmoidal abscess that it will be difficult to say which cavity is the seat of the disease.

Diagnosis.—In uncomplicated and well-marked cases the diagnosis is not attended with much difficulty. If the nasal chamber is not closed by the swollen condition of the turbinated bodies, pus of a light-yellow color will be found in the middle meatus, making its appearance from under the anterior extremity of the middle turbinated body. If the cells are over-distended, pus will be observed coming from the superior meatus and passing down between the septum and middle turbinal. While pus in the middle meatus is a symptom of ethmoid disease, it is one that is also common to both antral and frontal abscesses, and therefore it cannot be relied upon alone; but when taken in connection with a purulent flow into the post-nasal space, with pain at the root of the nose, at the back of the eye, and extending along the infra-orbital ridge, together with exophthalmus and a narrowing of the field of vision, the indications are that the seat of the trouble is in the ethmoid cells.

Prognosis.—Simple catarrhal inflammation of the ethmoid cells is not attended with any danger to life, resolution taking place as soon as the acute rhinitis with which it is associated has subsided. A suppurative inflammation of the sinus, on the other hand, is a much graver affection, and, as it is frequently attended with caries and necrosis, there is great danger of the inflammation extending to the orbital and cranial cavities, with resulting meningitis. The course of the disease is a slow one, owing to the inaccessibility of the numerous compartments or cells that are affected. It may extend over months, or, as occasionally happens when the inter-cellular partitions are broken down, the whole of the contents of the sinus may be discharged into the nasal cavity and a cure speedily result.

Treatment.—This consists in thoroughly cleansing the nasal cavities with mild detergent and antiseptic washes, removing polypi, and reducing hypertrophies that may be present, so that free drainage can be established. In a few exceptional cases this form of treatment may be all that will be

¹ Transactions of the American Laryngological Association, 1891, p. 63.

required. In the majority of instances, however, surgical interference will be found necessary; but before resorting to severe measures it must be borne in mind that these abscesses sometimes discharge spontaneously and others are relieved during the treatment of nasal polypi, as occurred in a case of mine reported to the American Laryngological Association, June, 1892, in which, after removing a mucous polyp with a small spicula of bone attached, the entire contents of the abscess were discharged through the nose and post-nasal space. Ziem was the first to open these cells, and advised that it should be done by first removing a portion of the turbinated body, thus bringing the superior meatus into view. An injection-needle is then carried up along the septum, and the cells entered and injected with a three-per-cent. solution of carbolic acid. Ziem does not seem to have been very successful with this mode of treatment, however. In the majority of instances the anterior ethmoid cells extend into the middle turbinated body, so that by removing its cap or the body as a whole, free access to the ethmoid cells is obtained. This is most readily accomplished by means of the Jarvis snare, the electrical drill, or the combined gouge and curette, illustrated in Fig. 6. This instrument is a modification of one devised

FIG. 6.



Combined gouge and curette.

by Max Schaeffer, and in my hands it has been a most serviceable instrument for opening these cavities. After the removal of the cap, or so much of it as is necessary to gain access to the ethmoid cavities, the individual cells can be entered with the sharp curette, the intercellular partitions, if not already absorbed, can be broken down, and their contents, including carious and necrosed bone, removed. While this operation is necessarily a painful one with only the aid of local anæsthesia, it will in many cases be found preferable to conduct it in this manner, owing to the great advantage of having the parts operated upon directly under inspection. If, however, it is necessary to place the patient under general anæsthesia, the parts can be brought into view by means of the electric head-light. Schech, owing to the difficulty in obtaining access to these cells through the nose, has advised that the operation of splitting the nose should be done, whereby a better view of the diseased parts is obtained. The external operation that offers the greatest advantages is that of Ollier,¹ who recently performed a temporary resection of the nose for an ethmoidal cyst in a boy sixteen years of age. By tilting the nose down an abundance of room was obtained, and he found a cyst the prolongation of which extended not only into the frontal but also into the sphenoidal sinuses, and

¹ Lyon Médical, Mars 3, 1889.

which could then be freely evacuated. After the cells have been opened the nasal cavity should be washed out daily with antiseptic washes, the parts insufflated with iodoform, and the nose plugged with antiseptic wool.

MUCOCELE OF THE ETHMOIDAL SINUSES.

Through the stoppage of the ostium ethmoidale an accumulation of mucus takes place in the cavities, and when they become over-distended the intercellular partitions are broken down and the sinus is converted into a single cavity. According to Berger and Tyrmann,¹ it is a rare affection, only seven authentic cases being on record.

Symptoms.—In general the symptoms are slow and painless in development, and later on a fluctuating tumor makes its appearance at the inner angle of the orbit. The eyeball is pressed outward and forward, and in the case reported by Ewitzky,² where the dilated ethmoidal sinus had extended into the frontal sinus, the eye was pressed downward. In case fluctuation is not present, the tumor is liable to be mistaken for an osteoma: its nature then can be determined only by an exploratory puncture. This affection is generally met with in individuals ranging from fourteen to twenty-seven years of age. If the dilated cavity presses towards the nose the septum will be displaced and the nasal cavity closed, so that its respiratory function will be interfered with.

Treatment.—The treatment consists in evacuating the contents of the tumor and washing out the cavity daily until healing has taken place.

POLYPI IN THE ETHMOIDAL SINUSES.

Myxomatous polypi may be considered as the most frequent variety of tumor-formation met with in these cavities, and, although they have been supposed to be relatively rare, they probably occur much more frequently than has hitherto been supposed. Bosworth,³ in speaking of the various forms of disease of the ethmoid cells, divides them into three distinct types,—viz., the extra-cellular myxomatous degeneration, purulent ethmoiditis, and the intracellular myxomatous degeneration, which may or may not be associated with a discharge of pus from the cells. In his cases the principal symptoms were a tendency to take cold, and nasal stenosis due to an enlarged middle turbinated body which was covered with a membrane resembling myxomatous tissue. Upon removing the cap of the middle turbinated body, soft gelatinous polypi were found, which were removed with the snare. Occasionally naso-pharyngeal polypi are found pressed into the ethmoid cells, and in these cases the symptoms are more pronounced: the nose is widened, the orbit narrowed, and exophthalmus produced.

¹ Op. cit., p. 32.

² Russische Ophthalmologische Zeitung, No. 1, p. 252.

³ Op. cit.

FIBROMA.

Fibroma of the ethmoid cells is an exceedingly rare growth; only one case having been observed, which occurred in the practice of Chiari.

OSTEOMA.

Osteomata of the ethmoid sinus usually arise in one of the neighboring sinuses. They are probably of congenital origin, and they occur more frequently among women than among men. During the period of growth there may be no positive symptoms observed, except an occasional neuralgia and frequent bleeding from the nose. The first objective symptom is the appearance of a hard tumor at the inner canthus of the eye; later on, a swelling of the neighboring cheek and protrusion of the eyeball. With the growth of the tumor the nasal cavity is encroached upon and the septum pushed to one side; the voice becomes nasal in character, and the respiratory function of the nose is interfered with. As the tumor continues to invade the orbital cavity the ocular symptoms will be noticed,—namely, disturbance of the field of vision, and exophthalmus. While osteomata of the ethmoid cells sometimes extend into the neighboring cavities, they do not tend to penetrate the cranial cavity, differing in this respect from osteoma of the frontal sinus.

SARCOMA AND CARCINOMA.

Among other forms of tumor met with in these sinuses may be mentioned sarcoma and carcinoma.

Treatment of tumors in this region is purely surgical, and consists, when possible, in extirpation of the new growth.

III. DISEASES OF THE SPHENOIDAL SINUSES.

The sphenoidal sinuses are lined by a mucous membrane similar in character to that lining the other accessory cavities, and continuous with the lining membrane of the nose. These cavities are occasionally the seat of a catarrhal inflammation, which may be acute or chronic, and in nearly all instances is secondary to a rhinitis or a naso-pharyngitis, or is in consequence of the extension of an inflammation from one of the other accessory cavities, especially the ethmoid, the posterior cells of which are in very close relation with the sphenoidal cavities. The positive symptoms of a catarrhal inflammation of these cells are generally wanting. At times, however, there is a sense of pain and weight referred to the middle region of the head, which is more severe than can be accounted for by the simple inflammation of the nose, and this symptom associated with either a continuous or an interrupted flow of mucus into the post-nasal space would indicate the sphenoidal sinuses or the posterior ethmoid cells as being the seat of the inflammation. Owing to the high position of the communicating opening of the sinus, the secretions are liable to be retained in the

cavity, overflowing occasionally into the post-nasal space, but when closed the cavity becomes distended and there results the condition known as *mucocoele of the sinus*. The symptoms of this affection are much more pronounced. In an interesting case reported by Rolland¹ the posterior nares were occluded by the bulging of the walls of the sinus, and the patient complained of violent headache, loss of memory, and insomnia.

Another and more serious form of inflammation of this sinus is a *chronic suppuration of its lining membrane*.

Etiology.—It occasionally occurs in the course of an acute catarrhal inflammation where there is retention of the secretion and consequent suppuration. Rosenthal² believes that it is most frequently the result of syphilis and scrofula affecting the nasal mucous membrane. According to Schech,³ it has also been noticed in consequence of tubercular meningitis and cerebro-spinal meningitis, the inflammation being transmitted through the small openings in the lateral walls of the sinuses which open directly into the middle fossa of the skull. Weichselbaum has observed abscess of the sphenoidal sinus follow facial erysipelas. When the inflammation is of such an intensity as to affect the deeper layers of the membrane, caries and necrosis of the walls of the sinus are likely to follow. Syphilis and scrofula also lead to caries and necrosis of the walls of the sinus, according to Berger and Tyrmann.

The secretion varies from a thick muco-purulent to a thin purulent consistency, and when there is disease of the bone present it becomes caseous in character.

Symptoms.—When the openings into the superior meatus are patulous, there may be only an interrupted flow of fetid pus into the nose and post-nasal space, with an intense pain referred to the middle and deeper parts of the head. It may also be felt in the different parts supplied by the trifacial nerve, and thus lead to error in the diagnosis. When the opening is closed the pain increases in intensity, and when the cavity becomes distended pressure is made on the surrounding parts, the optic nerve is compressed, and sudden blindness takes place. Upon ophthalmoscopic examination the characteristic swelling of the optic disk is observed. Exophthalmus and strabismus are frequently present. With the extension of the diseased process to the bony structure caries and necrosis result, and frequently terminate in orbital abscess and meningitis. If the cavity is much distended, the post-nasal space is encroached upon and the respiratory function of the nose interfered with.

Diagnosis.—The diagnosis of this affection is attended with considerable difficulty. If there is no swelling of the posterior extremities of the turbinated bodies, pus may be seen flowing out of the posterior part of the

¹ Revue Mensuelle de Laryngologie, etc., July 15, 1889.

² Die Krankheiten der Nase und deren Nebenhöhlen, etc., p. 227.

³ Op. cit., p. 334.

superior meatus into the naso-pharyngeal space; but in the majority of instances the turbinals are swollen and it is impossible to say whether the pus comes from the sphenoidal or the ethmoidal opening. The discharge of pus into the post-nasal space, taken in connection with the deep-seated pain in the head, sudden blindness, exophthalmus, and strabismus, would indicate the sphenoidal sinus as the seat of the affection, with possibly an implication of the posterior ethmoid cells.

Prognosis.—The prognosis of abscess of the sphenoidal sinus is very grave, owing to the tendency to necrosis of the sphenoid bone and to the extension of the inflammation to the brain. Scholz¹ reports a case where the inflammation extended from the sphenoidal cells to the cavernous sinus, producing a destruction of the bone, and the patient died from a profuse hemorrhage from the mouth and nose. This affection rarely terminates spontaneously, although Baratoux² reports one case in which the whole body of the sphenoid was expelled through the nose.

Treatment.—The indications for treatment are the same here as in the case of abscess of the other accessory cavities. If polypi or hypertrophies are present they should be removed by the usual methods, and any inflammation of the nasal cavities reduced by means of detergent and antiseptic washes. As soon as it is ascertained that there is pus in the sphenoidal cavity, and at this stage of the disease the bony partition which divides the two sinuses has been absorbed and they are converted into one, means should be taken to evacuate it. There are two methods of opening this cavity: one through the nose, proposed by Zuckerkandl and first performed on the living subject by Max Schaeffer, who used the sharp gouge illustrated in Fig. 6. This instrument is introduced through the nose along the upper border of the middle turbinated body; the handle is depressed, while the point of the instrument is pushed backward and slightly upward, and with a slight rotary motion is made to penetrate the cavity at its most dependent part. This operation should not be attempted without the aid of the posterior rhinoscopic mirror, as it is one that requires considerable skill, and it is not unattended with the danger of making too much pressure and so entering the cranial cavity. The same operation is done with greater safety to the patient with a small trephine propelled by the electric motor, as it requires less pressure and is under the control of the surgeon to a greater degree. After the opening has been established and the contents allowed to escape, the cavity can be explored with the curette and any carious bone or caseous secretion removed. The other method is to pierce the under wall of the cavity through the vault of the pharynx just behind the posterior nares. This operation is much more difficult to perform than the other, and is attended with even greater risk. The sudden relief of the pressure due to the escape of the fluid sometimes brings on dangerous

¹ Berliner Klinische Wochenschrift, 1872, No. 43, p. 576.

² Progrès Médical, 1883, p. 826.

syncope, as occurred in a case of mucocele operated upon by Rolland, where the patient was seized with violent nausea and a temporary loss of consciousness upon the escape of the fluid. The after-treatment consists in the daily washing out of the cavity with mild alkaline and antiseptic lotions.

TUMORS OF THE SPHENOIDAL CAVITIES.

Occasionally cysts and myxomatous polypi extend into these sinuses from the adjacent cavities, as the ethmoidal and frontal. The fibrous polypi which are sometimes found in the naso-pharyngeal space rarely, if ever, have their primary origin in the sphenoidal sinuses; but they frequently involve the cavity by absorption of their walls by pressure.

Osteomata occur in this sinus occasionally. They may arise within the cavity itself, or from the body of the bone. There are two varieties met with,—the small compact variety and the large ivory-like variety with its soft spongy nucleus. The malignant tumors, as sarcoma and carcinoma, are rarely met with primarily in these sinuses, affecting them generally secondarily, having extended from the neighboring cavities or from the base of the skull.

Symptoms.—As long as the tumors are small they give rise to no signs by which their presence can be detected. If, however, they attain sufficient size to cause much pressure, there will be pain referred to the middle region of the skull, and double blindness, with an encroachment upon the nasal cavities and the post-nasal space. The treatment of these tumors consists in extirpation when possible, and belongs to the domain of general surgery.

IV. DISEASES OF THE FRONTAL SINUSES.

ACUTE INFLAMMATION OF THE MUCOUS MEMBRANE.

The most common affection of these cavities is a catarrhal inflammation of the lining mucous membrane, and it always occurs as the result of an extension of the inflammation of an acute rhinitis into the sinuses. As these cavities are developed from the anterior ethmoid cells, it is not until about the fifteenth or seventeenth year that they commence to grow, and they are not fully developed until about the twentieth year: so diseases of the frontal sinuses are rarely met with under the age of puberty.

Symptoms.—Among the earliest symptoms of an acute catarrhal inflammation of the frontal sinuses is headache referred to the frontal region and to the supra-orbital ridge, which becomes more severe as the secretions accumulate and distend the cavities. The pain in the head is boring in character, and is generally persistent, although at times it is intermittent. It is increased by the movements of the head in coughing or sneezing, by mental effort, or by the use of alcohol, and it is occasionally accompanied by nausea and vomiting. While in the majority of cases pressure on the forehead or supra-orbital ridge does not increase the sensitiveness, on the

other hand the slightest pressure under the supra-orbital ridge at the internal angle will be followed by intense pain. Some relief is obtained when the contents of the cavity are expelled through the communicating opening into the nose. The mucus discharged is thick and yellow. The intenseness of the pain is thought by McBride to be due not so much to the inflammation of the mucous membrane as to a diminished atmospheric pressure brought about by the closure of the communicating opening in the nose.

Diagnosis.—The diagnosis can only be made by taking into consideration the above-mentioned symptoms either associated with or following an acute rhinitis.

MUCOCELE OF THE FRONTAL SINUS.

When the mucous secretion the result of a chronic catarrhal inflammation is retained in the cavity and cannot find an exit, the condition known as mucocele results.

Etiology.—It frequently occurs in the course of a chronic catarrhal inflammation which extends into the frontal sinus, and, the communicating opening becoming closed, the secretions are retained. Among other causes may be mentioned hypertrophic rhinitis, tumors such as polypi or foreign bodies in the nose blocking up the middle meatus so that free drainage cannot take place through the infundibulum, injuries of the frontal bone, and the various diseases of the frontal bone, such as caries and necrosis; and, according to Rosenthal, diseases of the antrum occasionally lead to mucocele of the frontal sinus.

Symptoms.—The symptoms vary according to whether the naso-frontal duct is open or closed. In the former case there will be a discharge of mucus from the nose, with occasional neuralgic pains in the frontal region. When, however, the duct is closed the symptoms are much more severe. The mucus continues to be secreted, and finally leads to dilatation of the sinus, generally confined to one side, but occasionally both cavities are involved. The cavity sometimes becomes enormously dilated, and the bones become so thin that a crepitating sensation is produced by pressure, and a soft fluctuating tumor is formed at the inner angle of the orbit. The eye is pressed downward and outward. In very pronounced cases the mucous membrane of the frontal sinus is forced through the opening between the orbit and the tear-duct into the nose, forming a tumor which obstructs the nasal cavity. It occasionally happens that the duct opens, when the mucus is discharged into the nose, and the tumor at the inner angle of the orbit and in the nose suddenly disappears, to reappear again upon the closure of the duct. The secretions are thick and fetid.

Pathology.—In the earlier stages the mucous membrane is swollen and hyperæmic, and in the later stages it becomes so thickened as nearly to fill the cavity.

Diagnosis.—The diagnosis of mucocele of the frontal sinus is sometimes

attended with considerable difficulty, but the swelling at the inner angle of the orbit, together with the occasional discharge of mucus through the corresponding side of the nose, will lead to a decision as to the nature of the affection.

Prognosis.—The prognosis of the disease is very favorable, for as soon as the cavity is opened and free drainage established the parts are restored to health.

EMPYEMA.

Abscess of the frontal sinuses is the least common of the inflammatory affections of these cavities. It is usually an affection of adult life, being met with most frequently between the ages of twenty-five and forty. It occurs more frequently in men than in women, which would seem to be explained by the fact that the cavities are more developed in men, who are also more exposed to cold and injuries than women.

Etiology.—The most active causes of abscess of the frontal sinuses are the same that lead to mucocoele, being traumatism, the passage of insects through the nose into the cavity, the eruptive fevers, syphilis and tuberculosis, and finally polypi developing within the sinus.

Symptoms.—The symptoms vary according to whether the passage into the infundibulum is open or closed. Pain in the forehead, at first dull and then becoming lancinating in character, increasing in severity as the secretions form and distend the cavities, is the most constant symptom. At times the pain is intermittent and neuralgic in character, and occasionally it is absent altogether; all that disturbs the patient is a sense of pressure at the inner angle of the orbit. When the naso-frontal duct is permeable there is a discharge of thick, yellow, fetid pus from the nose. Upon a rhinoscopic examination it will be found to make its appearance in the middle meatus just beneath the anterior extremity of the middle turbinated body. This constant flow of irritating pus into the nasal chamber frequently leads to hypertrophy and polypoid growths in the nose, a condition that is also observed as a result of empyema of the antrum, after the pus has been flowing into the nasal chamber for some time. So long as the secretion does not completely fill the cavity or is not discharged through a fistula, the symptoms are as above enumerated. When, however, the canal becomes closed the symptoms increase in intensity; there is fever, with chills or chilly sensations, and the pain becomes almost unbearable at times. Then follows dilatation of the cavity, and if there is a displacement of the posterior wall there will be symptoms of compression of the brain, such as dulness, increased headache, and a tendency to drowsiness. Generally at the inner angle of the orbit, or on a level with the root of the nose where the bone is thinnest, there appears a tumor which presses on the eye and causes it to bulge forward, downward, and outward. At the same time there is a swelling and redness of the skin of the supra-orbital ridge and of the upper eyelid. Besides the exophthalmus there are pain in the eye,

diplopia, and inability to close the lid. If the cavity is not opened by artificial means, the pus usually finds its way outward, but occasionally it passes through the thin posterior wall of the sinus into the cranial cavity, causing death from purulent meningitis.

Pathology.—The quantity of fluid that is found in these cavities is sometimes very large, and when they become distended the thin bony partition which divides them is broken down and the two sinuses are merged into one. The mucous membrane is red and swollen, but not to the same degree as in mucocele. Its surface is rough, containing granulations, and at times they are so large as to appear like fungoid excrescences. The membrane is occasionally thin and disappears, leaving the bone bare.

Diagnosis.—At first the diagnosis is not easily made. The first symptom may be mistaken for migraine, from which it differs in the persistency of the pain, its acuteness, and its position towards the sinus. It is only when the sinus has become distended and a tumor has formed at the inner angle of the orbit that the seat of the malady can with certainty be established. These symptoms when taken in connection with a purulent discharge from the nose, which upon inspection is found to come from the middle meatus, together with the ocular symptoms, confirm the diagnosis of abscess of the frontal sinus. An additional and valuable aid to the diagnosis is the transillumination of the cavities, which can be readily carried out by applying the electric lamp of Heryng, with its condenser attached, to the under surface of the supra-orbital ridge at the internal angle of the orbit. The room having been made as dark as possible, the connection is then made by pressing the button in the handle. If the sinus is in a state of health it becomes illuminated as high as the superciliary ridge, while if it should contain fluid it would remain dark. Abscess of the frontal sinus is liable to be mistaken for lachrymal abscess and erysipelas. From the former it differs in the primary seat of the affection and the permeability of the duct to tears. From erysipelas it differs by being associated with severe pain in the early stages, in the absence of the peculiar brawny and polished surface of the skin in that affection, and in the absence of the constitutional symptoms which mark erysipelas from the beginning of the attack.

Prognosis.—When recognized and treated early, the disease is not attended with much danger. When, however, it goes unrecognized for some time, there is a tendency to necrosis and an extension of the inflammation to the cranial cavity.

Treatment.—The treatment of an acute catarrhal inflammation of the frontal sinuses is that which is directed to the cure of acute rhinitis, and consists in the employment of disinfecting and detergent lotions to the nasal cavities. The intense pain in the frontal region is greatly relieved by the application of a pledget of cotton saturated with a twenty-per-cent. solution of cocaine to the entrance of the infundibulum in the middle meatus. The mouth of the naso-frontal duct is thus opened, and, free drainage being established, the pent-up secretions have an opportunity of draining out of

the cavity, which is greatly assisted by the patient forcibly blowing the nose. After this is done the cavity should be inflated by means of Politzer's air-bag in order to restore the atmospheric equilibrium as much as possible. Hot fomentations applied to the forehead will be very grateful to the patient and frequently lessen the pain.

In mucocoele and empyema the same object is to be sought,—the establishment of free drainage, so that the retained secretions can be discharged from the cavities. If these conditions are complicated by the presence of polypi or hypertrophic rhinitis, they must be removed, either with the snare or by means of the galvano-cautery, and if this fails to bring about an opening of the naso-frontal duct, an attempt should be made to pass a sound through the infundibular orifice, as recommended by Jurasz,¹ who used a fine and slightly-knobbed probe. The situation of the opening is in the anterior part of the infundibulum, and the probe should be pushed gently forward and outward until it meets with an obstruction at the entrance of the cavity.

While this procedure is possible in a few cases, in the majority of instances it is not practicable, owing to the opening of the infundibulum in the middle meatus not being visible, and to the impermeability of the duct. Then an artificial opening must be made through the bony wall of the sinus to secure the desired drainage. The incision should be made along the lower border of the supra-orbital ridge, beginning at the root of the nose and extending outward from an inch to an inch and a half. Panas² makes another incision perpendicular to this upon the base of the nose, and the triangular flap thus formed is detached from the bone together with the periosteum, and the sinus perforated, either by means of the drill, trocar, or trephine, near the inner angle of the orbit, where the bone is thinnest. The opening should be sufficiently large to admit the little finger, so that a thorough exploration of the cavity can be made both with the finger and the probe. If osteophytes or granulations are found, they must be removed by means of the curette. If the septum dividing the two cavities is not already broken down, a thorough examination of it should be made with the probe to ascertain whether there is a perforation present through which the secretions could pass into the adjoining sinus. If pus has found its way into the opposite sinus, the septum must be broken down by means of the probe, so that its contents may be evacuated. After the perforation has been made the sinus should be thoroughly irrigated with a solution of bichloride of mercury one to one thousand. If the naso-frontal duct still remains closed it will be necessary to re-establish the communication between the nose and the frontal sinus. This is best done by introducing the little finger into the nostril corresponding to the affected sinus, and then passing a trocar through the opening in the sinus into the nasal

¹ Berliner Klinische Wochenschrift, 1887, No. 3.

² Archives of Ophthalmology, vol. xx. p. 653.

cavity, using the little finger as a guide. A rubber drainage-tube is then introduced through the nose into the frontal sinus, after the method of Panas, and allowed to remain until all suppuration has ceased. The cavity should be irrigated daily with antiseptic lotions, such as a solution of the bichloride of mercury or the peroxide of hydrogen. When the suppuration has ceased the drainage-tube can be withdrawn and the cavity allowed to heal. The duration of the treatment varies generally from one to six months, according to the severity of the inflammation.

TUMORS OF THE FRONTAL SINUS.

The various forms of new growths that are met with in the frontal sinus are cystoma, myxoma, fibroma, osteoma, sarcoma, and carcinoma. Their development causes considerable distortion of the walls of the sinus and a displacement of the neighboring parts; absorption of the bony walls is produced by pressure, and occasionally the tumor penetrates the thin posterior wall, causing cerebral disturbance.

Cystoma.—Cystic tumors are the most frequent forms of morbid growths met with in this sinus. They may be serous, hydrated, or steatomatous in character. They are liable to occur at any age, and are even congenital.

Myxoma.—Myxomatous or gelatinous polypi are rare. They are either single or multiple. While they may develop within the cavity, as a rule they are formed within the nasal cavity and extend into the sinus.

Fibroma.—Fibroma is occasionally met with in this sinus. It is usually single, and may extend into the nose, or it may extend upward and backward into the cranial cavity.

Osteoma.—Osteomata occurring in the frontal sinus may spring either from the diploe or from the mucous membrane. They are composed either of cancellous tissue, or of compact tissue which renders the tumor hard and ivory-like, and they may attain a great size, causing considerable deformity. They show a tendency to perforate the cranium; and in this respect they differ from osteoma of the ethmoid cells.

Among the malignant growths met with in the frontal sinus are sarcoma and carcinoma. The former, according to Gross, is much more frequently met with than is generally supposed.

Symptoms.—The symptoms of tumors of the frontal sinus are headache, severe paroxysms of neuralgia, distortion of the walls of the sinus, displacement of the eye, disturbances of the vision, swelling of the upper eyelid, epistaxis, and a muco-purulent discharge from the nose.

Diagnosis.—Until the tumor has developed sufficiently to produce characteristic symptoms, it is difficult to determine the variety of the growth. Its presence must be determined by the severe localized pain, the increasing deformity produced by the growth of the tumor, and the displacement of the eyeball, together with recurring epistaxis. When the bone has become thin the contour of the tumor can frequently be made out by palpation. Palpation under the supra-orbital ridge will sometimes detect the presence

of the growth. Cysts are often mistaken for mucocoele of the sinus, and when surrounded by a hard bony envelope they are likely to be mistaken for osteoma. Their true character can be determined by an exploratory puncture.

Prognosis.—With the exception of cysts and myxomata, the prognosis of tumors in this sinus is unfavorable, as they have a tendency to involve the cranial cavity.

Treatment.—Cysts and myxoma may be removed by external incision with favorable results; but in the case of solid tumors when they show symptoms of internal extension their removal is not often successful.

FOREIGN BODIES IN THE FRONTAL SINUSES.

Foreign bodies are occasionally met with in the frontal sinus, and they are generally the result of gun-shot injuries or fractures. An interesting case of gun-shot injury was reported by Peter,¹ of a man who was wounded in 1864, the ball entering the sinus at the inner angle and remaining in the cavity until 1870, when it was removed. Other forms of foreign bodies sometimes found within this cavity are parasites. While maggots in the nose and in the neighboring cavities is thought to be a very rare affection in this country, I believe it occurs much more frequently than is generally supposed, judging alone from the number of cases that have been reported within the last few years. Such a condition has been known for a long time in the East and West Indies, in Mexico, and in South America, and most of our information on the subject has been derived from the writers of those countries. The most perfect description of the affection in the English language is that by the late Sir Morell Mackenzie.² The fly that

FIG. 7.



Side view of head and mouth parts of screw-worm fly (*Comptosia macellaria*). (Natural size represented by line beside figure).

FIG. 8.



Screw-worm fly, wings expanded. (Natural size represented by crossed lines under right wing.)

deposits its eggs in the nose from which the screw-worm or larva is developed is the *Comptosia macellaria* (*Lucilia hominivora*), and is illustrated

¹ American Practitioner, 1870.

² Diseases of the Throat and Nose, vol. i. p. 448.

in Figs. 7, 8, and 9. The larva (Fig. 12) as soon as it is formed works its way into the sinus through the naso-frontal duct, where it produces a most intense inflammation, causing great destruction of the soft parts, and leading to caries and necrosis of the bone. In this country the affection is principally met with in some of the Western States and in Texas, whence the larva receives its name of Texas screw-worm. It is observed mostly

FIG. 9.



Screw-worm fly, wings at rest. (Natural size represented by lines on right side of fly.)

FIG. 10.



Single egg of screw-worm fly, greatly enlarged. (Natural size represented by line beneath figure.)

FIG. 11.



Bunch of eggs of screw-worm fly.

FIG. 12.



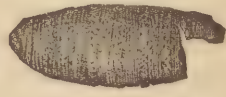
Larva, or "screw-worm" (*Lucilia hominivora*). (Natural size represented by line beneath figure.)

FIG. 13.



Pupa, or chrysalis, of screw-worm fly. (Natural size represented by line beneath figure.)

FIG. 14.



Pupa case, showing broken end where screw-worm fly emerged. (Natural size represented by line beneath figure.)

in those who live in the country, and especially in those who have to care for cattle.¹

Symptoms.—Several cases have been reported in this country recently in which the detailed symptoms have been marked depression of the general health, followed by intense frontal headache, frequent epistaxis, a mucopurulent discharge from the nose, and severe swelling of the eyelids. The patients become delirious, and frequently develop suicidal mania.

Diagnosis.—It is often difficult to determine the presence of a foreign body in the sinus unless there is some history pointing to its introduction. In the case of insects it is impossible unless the larvæ are found in the nasal discharges.

¹ The figures (7-14) of screw-worm fly, larva, and pupa are from electrotypes kindly lent by the Texas Agricultural Experimental Station, College-Station, Brazos Co., Texas.

Prognosis.—This is favorable when the presence of the foreign body is detected early. In the case of maggots in the sinuses they have frequently produced so much destruction of tissue before their presence is recognized that many cases terminate fatally.

Treatment.—As soon as the presence of the foreign body in the frontal sinus has been determined upon, the sinus should be opened by external incision and the body removed. If the screw-worm is found in the sinus, remedies must be injected into the cavity that will destroy it. The most efficient have been found to be chloroform and a solution of the bichloride of mercury (one to one thousand).

DIFFERENTIAL DIAGNOSIS BETWEEN THE DISEASES OF THE ACCESSORY CAVITIES.

The differential diagnosis between the diseases of the accessory cavities is frequently attended with great difficulty. The first question to decide is whether the cavities are the seat of disease, and then which are affected. In the case of inflammation of the sinuses the first symptom to which our attention is attracted is a muco-purulent or purulent discharge from the nose, and generally it is unilateral. There are several conditions which can give rise to pus in the nasal chambers besides inflammations of the accessory cavities,—viz., foreign bodies, polypi, caries, necrosis, gonorrhœa, and a rare form of purulent rhinitis described by Störk as occurring epidemically among the Jews of Poland, Galicia, and Bessarabia. Fortunately, it rarely, if ever, occurs in this country. If after eliminating the presence of polypi, foreign bodies, or disease of the bones, or, if present, after their removal, the flow of pus continues, the evidence is almost positive that its source is one or more of the accessory cavities of the nose.

The presence of pus in the middle meatus may be indicative of inflammation of the antrum, of the anterior ethmoid cells, and of the frontal sinus. The two latter cavities discharge their contents through a common opening, the infundibulum just anterior to the ostium maxillare. In the case of the antrum the pus is generally confined to the middle meatus; it is intermittent in flow, and occasionally a pulsating light-reflex is observed. This symptom, so far as I am aware, has not been observed in suppuration of any of the other sinuses.

The position of the head will occasionally assist us in determining the source of the pus. If the nose be cleared of all secretion and the head inclined forward, at the same time rotating it slightly so that in case of suspected antral disease the suspected cavity should be upward, pus that finds its way into the middle meatus would probably come from the maxillary sinus, as the upright position alone favors the discharge from the frontal and ethmoidal cavities, the discharge from which is continuous. The intermittent flow of pus, and the intermittent fetor of the breath, a symptom upon which Luc lays great stress, will also serve to distinguish antral from frontal and ethmoidal disease.

It is impossible in the case of suspected frontal and ethmoidal abscess to determine the source of the pus from its location alone. It is only by taking into consideration other symptoms that we can be enabled to differentiate between them. When the posterior ethmoidal cells and sphenoidal sinus are the seat of the disease, the pus flows into the post-nasal space. The communicating openings of these two cavities lie very close together in the superior meatus, but, the ethmoidal opening being a little anterior to the sphenoidal, the secretions from it under favorable circumstances may be seen to pass into the posterior nares, while those from the sphenoidal sinus are seen flowing over the posterior extremity of the middle turbinated body into the post-nasal space. The electric-light test, which has been hitherto unsatisfactory and deceptive, will be better understood in the future, since Davidsohn has called attention to the illumination of the eye as a positive aid in the diagnosis of abscess of the antrum. The method of Moritz Schmidt of making an exploratory puncture through the lateral wall of the nose is the only certain means of ascertaining the presence of pus in the maxillary sinus. In the case of abscess of the frontal sinus the cavity remains dark when the electric light is placed under the supra-orbital ridge, while its fellow of the opposite side remains translucent.

The location of pain is a valuable aid to the differential diagnosis. It is generally unilateral, and in the case of the antrum it is most marked in the region of the cheek-bone and upper teeth. In abscess of the frontal sinus the pain is felt at the root of the nose, extending along the supra-orbital ridge, and becomes a general frontal headache. In long-continued disease of the frontal sinus there is tenderness over the root of the nose, and redness and œdema of the upper eyelid. While in ethmoidal abscess the pain is referred to the inner angle of the orbit, and extends outward along the infra-orbital ridge, in sphenoidal disease the pain is more in the middle of the head, radiating along the various branches of the trifacial nerve to the occiput, neck, and supra-orbital region.

Exophthalmus is generally present in well-marked cases of ethmoidal and frontal affections, and occasionally in sphenoidal. In ethmoidal disease the eye is pushed forward and outward; in frontal disease it is directed forward and downward; while in sphenoidal disease the eye is pushed directly forward and slightly outward.

Sudden blindness together with ptosis and strabismus and associated with a purulent discharge from the nose and into the post-nasal space would be indicative of sphenoidal disease.

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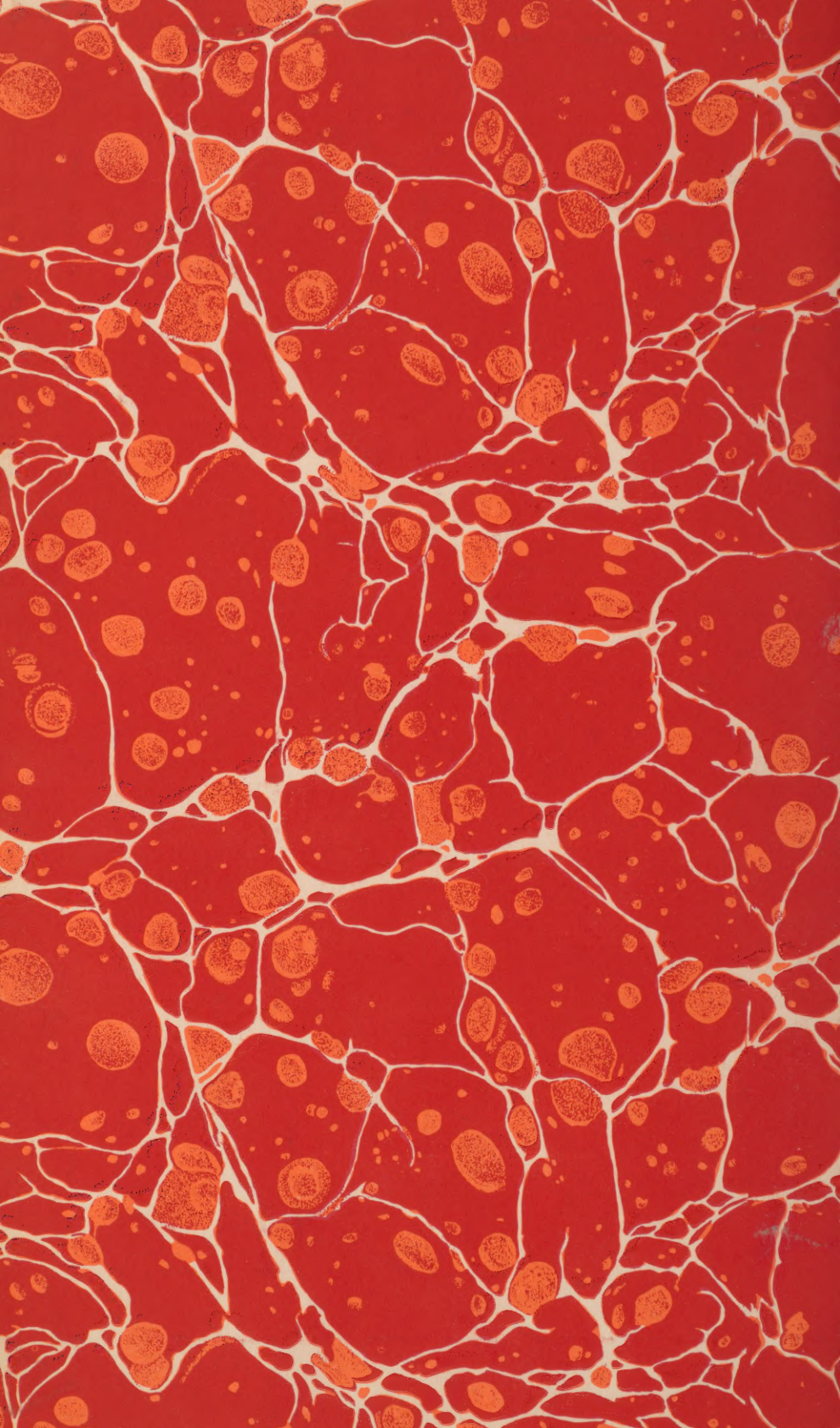
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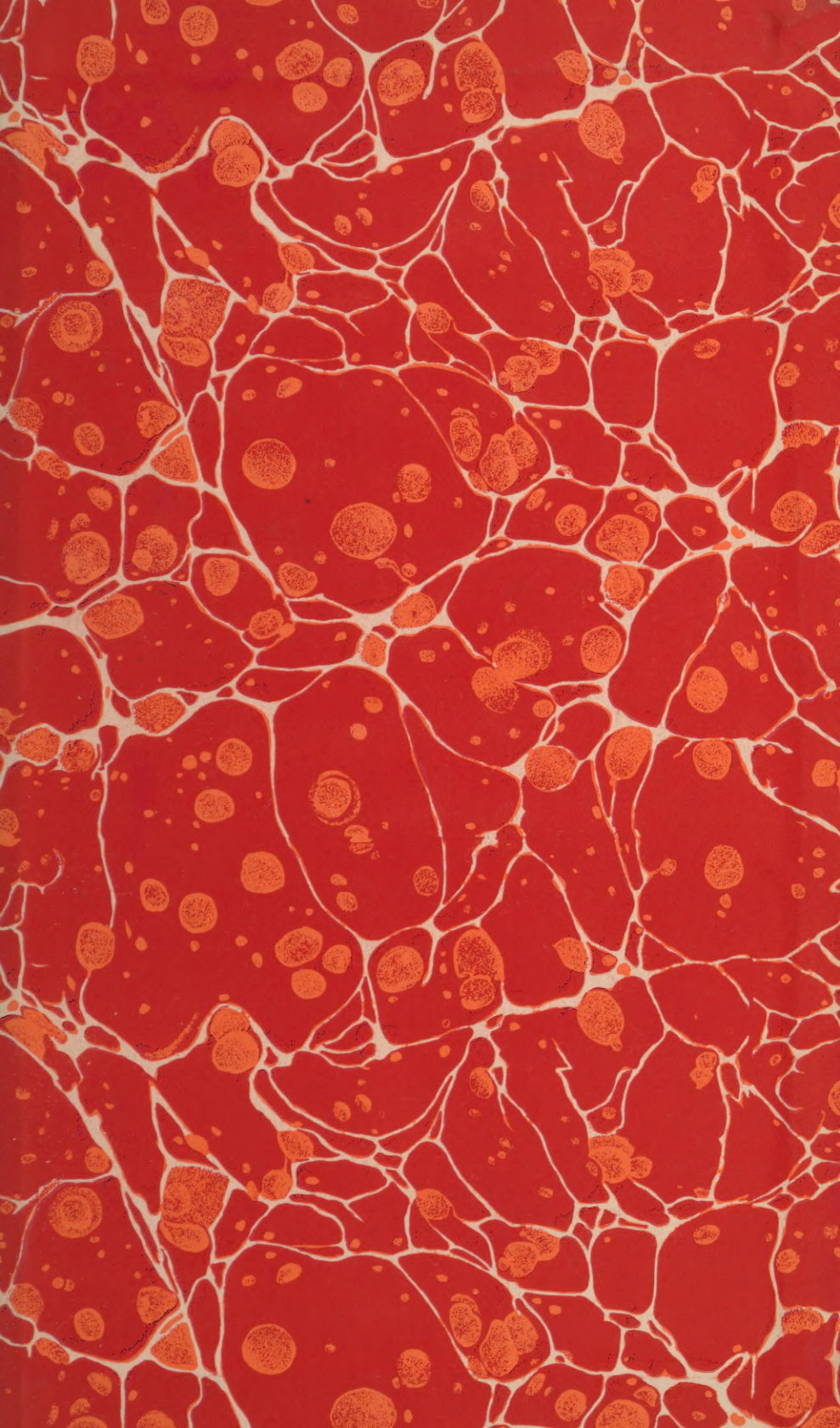
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